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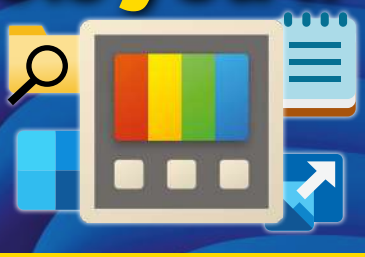

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HIGHLIGHTS THIS MONTH

Full contents overleaf

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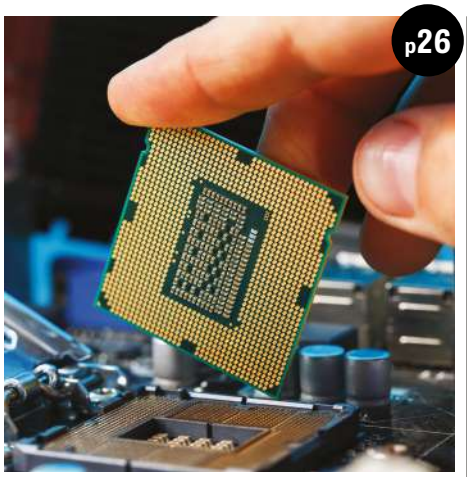
REVIEW OF THE MONTH

Dell 14 Premium

If you're looking at the photo and thinking "hmm, looks a lot like last year's Dell XPS 14", then give yourself a pat on the back and five *PC Pro* points. This laptop may have a new name as part of Dell's rebranding exercise, but it's fundamentally the XPS sharpened up for life in 2025, complete with Nvidia RTX 4050 graphics and a powerful "H series" Intel Core Ultra processor. Everything we loved about the old XPS series is here, along with a couple of inclusions that we're less enamoured with, and if 14 inches simply isn't enough then turn to p52 for our review of the Dell 16 Premium.



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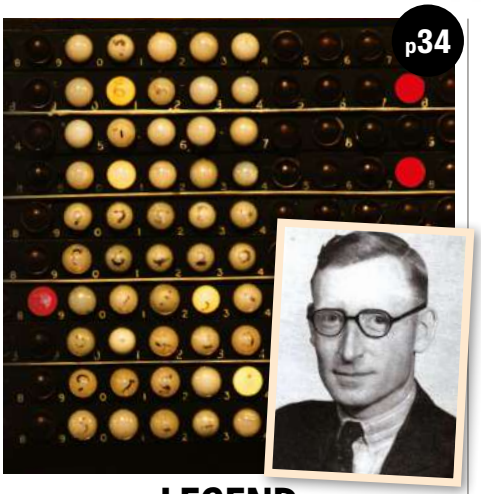
If you want to build or specify the best possible PC you can for your budget and your needs –and avoid the pitfalls that beset many builders – read our experts' advice.



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Christian Simpson

Can this man save Commodore? We certainly hope so. The brand that gave us the PET, Commodore 64 and the Amiga now has a team of enthusiasts back at its helm. We reveal the story of the takeover and what will happen next.

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THE LABS IN ONE NAME

Eight years ago, our annual group test of content creative workstations was dominated by Intel, with seven of the eight systems on test opting for a Core i7. That now seems like a long time ago, with AMD once again in command this month.

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8 Windows tools you'll use every day

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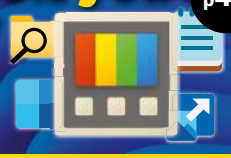
Hidden PowerToys to give YOU control



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HOW TO BUILD A GREAT PC

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PCSPECIALIST

Pass me those driving gloves: my laptop's days are numbered

It's been 23 years since I last used a desktop PC as my main home computer. I know this because it coincides with the birth of my first child, when the second bedroom in our tiny cottage suddenly found a more important use than housing my state-of-the-art tower PC. Made by Evesham Computers, if memory serves, so we really are going back into history.

This transition also marked my final days of playing *Championship Manager II* for countless hours, with that pastime replaced by fear/awe/wonder as I struggled with what it meant to be a parent. Instinctively, I somehow knew it had nothing to do with scouring the African leagues for the next wunderkind. After all, I had one of my own.

Today that kid is flying the nest, to such an extent that he's moving to New Zealand for the next three years – was it something I said? – and in a complete coincidence of timing I find myself wondering whether this is the moment to switch back to a desktop. I'm inspired partly by our group test of thundering content-creation workstations this month (*see p76*), and partly by speaking to people like Lee Grant, Ben Miles and Dave Gornall for our lead feature on how to build a great PC (*see p26*). Although that title doesn't even begin do the feature justice, as it's also about choosing the right mix of components and capabilities, even if someone else is building the system for you.

Much of their advice centres around building your PC for a purpose, with the topic of gaming cropping up time and again. While I certainly "game", I've never been a rabid gamer. Back in the early 2000s I joined in the *PC Pro* team's sessions of *Quake II* and *Kingpin* over the office LAN, but that was more for social reasons than any consuming desire to run around mazes shooting people. However, something about simulators has always grabbed me, causing me to while away hours, days, playing *SimCity* on my Psion, and more recently on Android.

Racing simulators are a particular weakness, and this is what may lure me back to the desktop. I currently use *Dirt 5* to test the performance of laptops and PCs when I'm reviewing them, having moved on from *Dirt: Showdown* a couple of years ago. The newer version brings a big jump in realism that makes the game much more interesting to me. What I really want is a racing game where I genuinely feel like I'm there; for that I'd not only consider buying an ultra-powerful desktop gaming PC, I'd start looking at bucket seats, 40in curved displays, racing wheels and pedals. The only downside is that I'd spend far too much time on the track and you might never see a new issue of *PC Pro* again.

I could buy a gaming laptop, of course, but this is one area where I raise an eyebrow in Nvidia's direction and wiggle it accusingly. Sure, the mobile version of the RTX 5080 GPU is based on the same Blackwell 2.0 architecture as the desktop version, but it has far fewer CUDA cores, tensor cores or ray-tracing cores. No surprise, then, that the desktop RTX 5080 is around 50% faster in games. Is it even fair to market the two GPUs under the same name?

Whatever you think about the branding, the huge difference in graphical power is yet another reason to think that – like the readers who voted in our poll this month (*see p25*) – I'm leaning towards a desktop PC for my next system.

Tim Danton
Editor-in-chief

CONTRIBUTORS

Tommy Flowers
Tommy (or Tom as he preferred to be called in later life) didn't actually write any articles this month, but he was the creator of Colossus, as we cover from p34

James Morris
Take pity on James, who had to test 11 power-guzzling, heat-generating content creation workstations during one of this summer's heatwaves. Discover his picks from p76

Jon Honeyball
As the law aiming to block children viewing adult content came into force, Jon decided to put the age-verification systems to the test. All will be revealed on p110

Olivia Whitcroft
Sticking with our legal theme, Olivia explains the ramifications of the Data Use and Access Act 2025. Discover why her LinkedIn followers are excited on p116

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This month's issue includes the true story behind the creation of Colossus (*see p34*), but what's the oldest computer you've ever used?

"If you have the June 1979 issue of *Personal Computer World* to hand – and who doesn't? – then turn to p38 where you'll see a photo of me playing on the MSI 6800 System One, which my father (Stuart) reviewed for them. 'It boasts an MC6800 microprocessor, up to 56K bytes of RAM and built-in backing storage provided by mini-floppy discs,' he wrote. Wild times!"

"First analogue computer was one we built at school in 1962 for a competition. First digital computer was London University's Atlas mainframe in 1969 to process scintillation counter data."

"Probably some sort of mainframe when I accompanied my father on an early 'take your child to work' day – but I never saw the computer itself, only the terminal on his desk!"

"A *very* old machine that I used at the BT Museum when I was about nine. It ran on punched tape and I still have the punched tape that I made there by typing something or other into the machine. There was also a computer with a voice synthesiser and I remember the sign requesting you not to make it say rude things as the voice was routed out through speakers in the ceiling. What were they thinking?"

"I guess the oldest I used 'in anger' was a DEC PDP 11/70 followed by an Apple Lisa, Apple IIe and some Sinclair calculators with ideas above their station."

"A BBC Micro. I'd been kept behind after school so the teacher went down the corridor, returning with beige boxes on a trolley. Within five minutes I was playing Clogger (tinyurl.com/373clogger) and the teacher was back behind the desk, loading his pipe. This formative experience would go some way to underpinning my diabolical academic record."

"Apple II. Or Prime mainframes. Whichever came first!"

"So I don't know what the oldest computer I used was, but I do know the first PC I bought myself was in 1999. It was a Pentium III and I felt like NASA."

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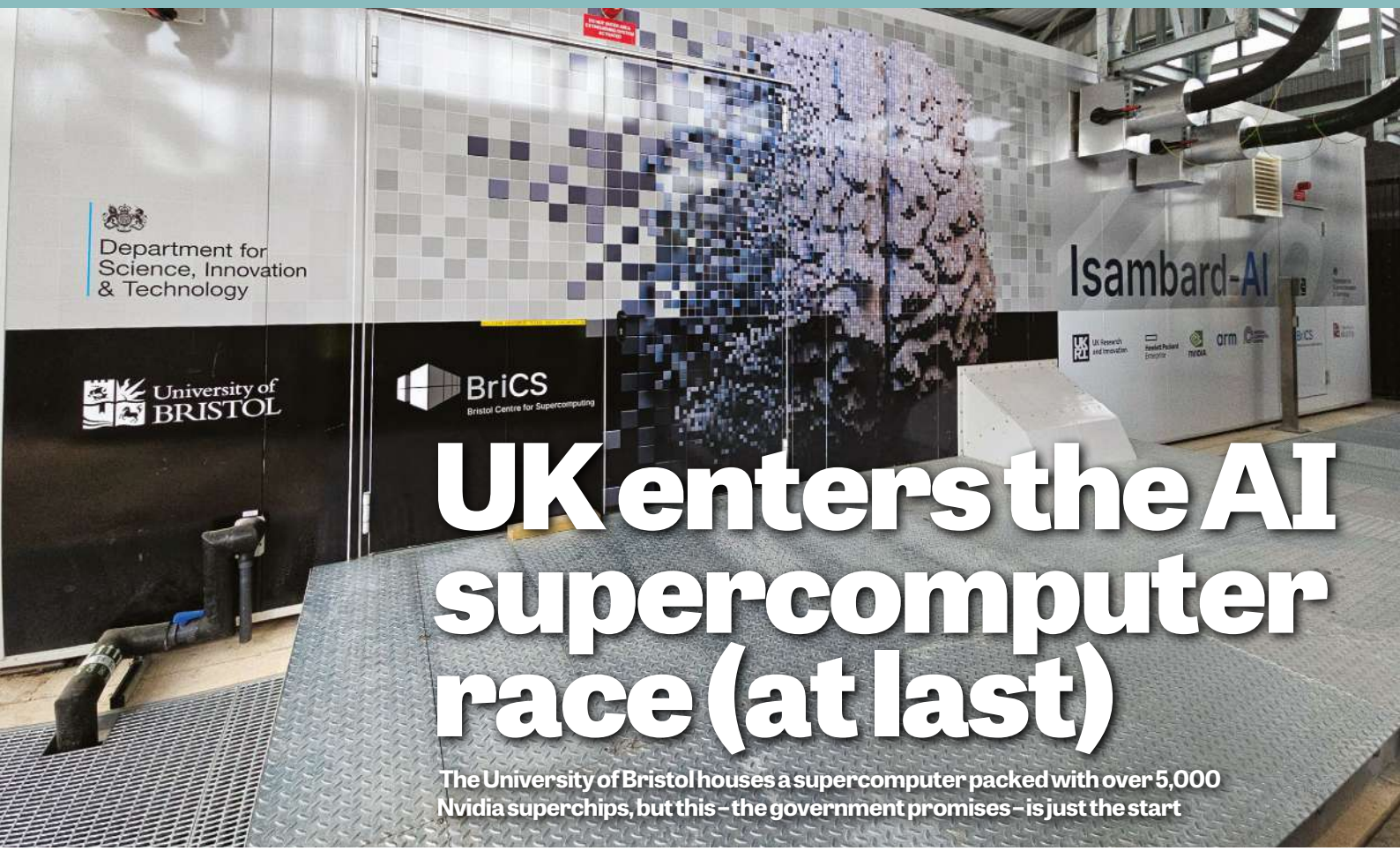


UK enters the AI supercomputer race (at last)

The University of Bristol houses a supercomputer packed with over 5,000 Nvidia superchips, but this – the government promises – is just the start

We saw the first sign of the UK government's AI strategy with the recent unveiling of the world's 11th most powerful supercomputer at the University of Bristol. Isambard-AI is formed of 12 cabinets, each packed with 440 Nvidia Grace Hopper superchips, and is now the cornerstone of AI research in Britain, being free of charge to academic researchers but also open to commercial use – for a price.

"Today we put the most powerful computer system in the country into the hands of British researchers and entrepreneurs," said the secretary of state for science, innovation and technology, Peter Kyle at the supercomputer's launch. "Isambard-AI doesn't just close the gap with our international competitors – it propels the UK to the forefront of AI discovery."

He then added: "With our AI Research Resource [AIRR] now fully up and running, the UK is home to the raw computational horsepower that will save lives, create jobs and help us reach net zero ambitions faster."

Beginning of the road

On the same day, Kyle unveiled the UK Compute Roadmap (**tinyurl.com/373roadmap**). This includes four "purposeful" steps, with the first being to build a "modern public computer ecosystem providing the capacity and certainty UK researchers and innovators need". The second is a rather simplistic step of "putting compute to use", with the third a promise to build a "cutting-edge AI infrastructure so that the UK can play its role at the frontier of AI". The fourth and final step is to create a "sovereign, secure and sustainable capability".

ABOVE Peter Kyle MP at the unveiling of Isambard-AI

Across 2025, this means an investment of up to £750 million for a new national supercomputer at the University of Edinburgh. To put this into perspective, Isambard-AI cost around £225 million. The new supercomputer should come online in 2027, and would sit in the top five supercomputers in the world in today's rankings.

The government has also pledged around £250 million to "scale" the UK's AI Research Resource, and has promised to identify AI Growth Zones across the country – including Scotland and Wales. Northern Ireland is not mentioned in the roadmap.

"The UK government's ambition by 2030 is to have a minimum of 100,000 GPUs available to the market," said Professor Simon McIntosh-Smith, director of the Bristol Centre for

Supercomputing, in a briefing shortly before the supercomputer's official launch. "If you're [an] astronomer, you need a telescope. If you're a data scientist, you need a supercomputer. It's very simple. You can't do the work [without it]."

"[The] UK has some of the world's best data scientists," added David Hogan, Nvidia's European vice-president. "It has some of the world's best AI startups. And the thing that's missing in that flywheel of making the economy work, from an AI perspective, is compute, and today we have that first element that's been delivered, but we need to do much more, from a UK perspective, to grow and expand that."

Where Isambard-AI fits in

There's little doubt that the UK has fallen behind its rivals when it comes to AI supercomputing. Even with the arrival of Isambard-AI, it sits one place outside the top ten: the USA houses four of the five of the world's fastest supercomputers, Germany the fourth fastest and Italy has two in the top ten. Aside from Isambard-AI, the UK's best performers sit in 26th and 63rd place in the official list (last updated in June 2025).

There is a sense of catch-up and hurry-up in the UK's approach. "Remarkably, it only took 18 months for Isambard-AI to go from being commissioned to built," said Professor McIntosh-Smith. "Normally this process takes three to five years for such a supercomputer.

"We treated the project like a high-performance processor," he added. "We executed everything in parallel." Phase 1 of the project, which included 168 Nvidia GH200 Grace Hopper superchips, finished in summer 2024. And those chips really are super, with each one containing a 72-core CPU and Nvidia's powerful H100 GPU.

Between January and early June 2025, almost 60 different research projects took advantage, using around 100,000 GPU hours in total. But that's just the start: Phase 2 saw a huge jump to a total of 5,448 GH200 superchips.

Put to use

UK academics are already bidding for time on the machine, with one headline project being the "Nightingale AI" model for the NHS. Trained on NHS data, this is a sovereign, multimodal health foundation model. The idea is to personalise care and make diagnoses earlier.

"We are launching a major AI program to harness the vast resources of UK healthcare and biomedical data," said Professor Aldo Faisal, director of the UKRI Centre for Doctoral Training in AI for Healthcare at Imperial College London, earlier this year when Nightingale AI was first announced.

"Our goal is to develop a novel generation of AI foundation models, trained exclusively on healthcare data rather than generic text. This approach will enable us to create a truly transformative system tailored for the medical community."

Then there's BritLLM, a British large language model, as you may have guessed. It's designed to be used by government services – including healthcare and education – and promises to promote inclusivity.

"Isambard-AI is the most exciting development for natural language processing research, and LLM research in particular, in the UK to date," said Pontus Stenetorp, professor in natural language processing at University College London at ISC 2025.

"We have already been able to produce state-of-the-art, multilingual LLMs with the help of Isambard-AI and over the next few years it is our hope that with access to these resources we will be able to answer fundamental questions about how LLMs operate."

> "Isambard-AI is the most exciting development for natural language processing research, and LLM research in particular, in the UK to date"

BritLLM is trained on British languages – including Welsh – and aims to promote inclusivity and better delivery of public services such as healthcare and education.

Nvidia's Hogan believes Isambard-AI offers big opportunities for businesses too. "We also announced a training programme with the government just a few weeks ago," he said, "where we're going to train 100,000 people in AI using our deep learning institute programme. So that's really enabling people to transition their workloads and know how to leverage these AI models.

"And that's the opportunity. You should see Isambard as almost an incubator for AI. This is a platform: people should come here and build their business on AI, prove that out, and then take that into the world and build another infrastructure and start to scale. This is really the starting point of the journey."

GPT-5 hiccups into existence

The much-heralded LLM caused more annoyance than awe at the start

OpenAI made big promises with the launch of GPT-5 in August, describing it as its "smartest, fastest, most useful model yet, with built-in thinking that puts expert-level intelligence in everyone's hands".

Perhaps Sam Altman should have asked it about how to avoid annoying its loyal subscriber base pre-launch, with Plus subscribers – who pay £20 per month – quickly complaining that they had used up their allotted resources.

You now have a choice between Auto, Fast and Thinking, where Fast provides instant answers, and Thinking will take up to 30 seconds to provide a reasoned-through answer. Altman reckoned most people should stick with Auto, which allows GPT-5 to decide how long to take, but paid-for subscribers demanded more control.

At launch, Plus subscribers were limited to 200 Thinking messages per week, fewer than with GPT-4o. OpenAI quickly responded to the complaints, raising the limit to 3,000.

"The upgrades matter: a 400,000-token context window, a set of models that can route work internally for efficiency, and pricing around $1.25 per million input tokens," said Shanti Greene, head of AI and data strategy at Infocepts. "I have been using it since the Horizon beta. It is fast, consistent, and priced in a way that changes how many teams can justify running larger workloads."

ABOVE OpenAI was forced to increase the number of "Thinking" queries Plus subscribers could make

But smart businesses should make sure they're using the right models for the right tasks. "This is not about finding the single 'best' option any more," Greene said. "It is about building a toolkit where each model has a defined role. GPT-5 might handle the bulk of general-purpose work. Claude 4.1 Opus is still the safer choice when flawless code matters. Gemini 2.5 Pro is unmatched for processing huge datasets in one shot."

He added: "That is the new economics in AI. Keep your options open, route work where it makes sense, and use models like GPT-5 to free up budget for the specialised tools that actually move the needle. The winners will be the ones who treat AI like a portfolio to manage, not a single bet to place."

The Interview

Rubbishing the UK's 5G coverage

Philip Maguire, Inakalum

Bin lorries are revealing how poor the nation's mobile coverage really is

When the bin lorry comes trundling down the road, few people would expect it to be doing anything more than collecting the rubbish. However, it might well be helping to identify one of the many holes in the UK's mobile coverage.

Inakalum measures the actual throughput delivered by the country's major mobile networks in a variety of ways. CEO Philip Maguire told us why the company's equipment is being installed on bin lorries and reveals the dire state of our mobile networks' performance.

PC Pro: How did your company get started?

We started in 1995 and we've been writing telecoms software ever since. In around 2017, we started developing a new platform for geospatial mapping. We started with public places, places of interest, and then moved into street asset mapping.

Obviously, there are ten times as many street assets as there are public places, so we needed to speed it up. So we added AI to use image recognition, so that when you take a photograph of a bollard it says "this is a bollard" or whatever.

When we started showing that to people, they said that would be really interesting for small cells for 5G and 4G intensification. And when we showed it to the telecoms people, they said if you could survey the [mobile] coverage in those areas to go with the assets, that would be really, really interesting. So we went, "Okay, back into telecoms we go!"

PC Pro: You've recently started a project in Tees Valley, where you've put your measuring equipment on bin lorries. Why bin lorries?

Philip Maguire: Everybody gets their bins collected, so the lorries travel every street. So, we know that we get the full coverage and the baseline survey.

> "Everybody gets their bins collected, so the lorries travel every street"

The kits are portable, they're battery powered, so they work for two days once they're charged. We can do backpack surveys, walking surveys, or put them into other vehicles that are driving in higher footfall areas, like the cage vehicles that empty the bins on the high streets.

PC Pro: How often do the kits attached to the bin lorries take measurements?

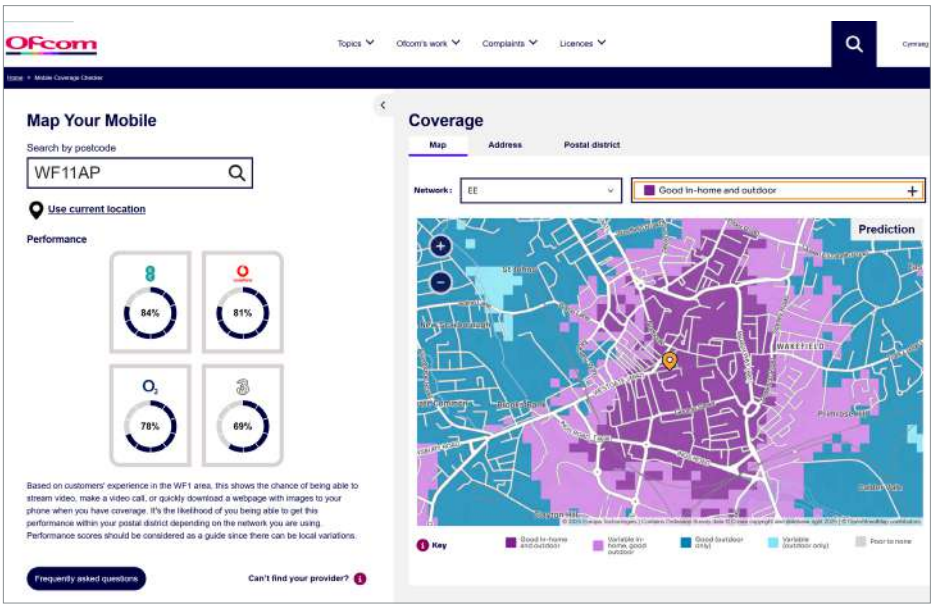
Philip Maguire: We have them set up to trigger every 30 metres or every 30 seconds... because they're stop-start. So it turns out that probably every five to ten metres along a street we get one [reading]. When we do bin lorry surveys, we usually do it three times. So we get really granular data.

PC Pro: You don't only measure coverage, but data throughput, too. What does this reveal about the state of the UK's mobile networks?

Philip Maguire: There are huge capacity problems in the UK, which are characterised by when you have three or four bars on your phone, but your [loading] wheels keep spinning and you can't load Google Maps or shopping online – very basic functions that don't have huge bandwidth requirements – but that happens all the time. Everywhere we observe it, there are big capacity problems, and that's what we specialise in finding.

I surveyed one of the rail lines last week, spent seven days travelling from London to Brighton return surveying for Ofcom. If you travel into one of the London train stations at eight o'clock in the morning, you'll get really, really poor service on your phone. But if you're travelling out of London, you get good service.

LEFT Inakalum uses portable battery-powered surveying kits that are carried by bin lorries



ABOVE Ofcom's coverage map only tells half the story when it comes to real-world usage

Even if it's in the same area, exactly the same route that you travelled up – you'll get good service on the way back, because the train is busy and full and we have more competition for bandwidth [on the way up], as opposed to empty [on the way back].

PC Pro: Why do local authorities go to the expense of measuring mobile phone coverage in their areas?

Philip Maguire: There's been a huge change in local authorities' approaches to mobile coverage. When we started doing this, every council we spoke to said, "look, that would be really interesting data, but we have no control over the mobile service, so we're not going to pay for surveys".

Now, they're all going out to tender and looking for people to survey the mobile coverage because they have realised that so many of their own services depend on mobile coverage. They have a lot of care workers in the community who all use their smartphones for logging cases and updating case files, etc.

Another use case is a lot of vulnerable residents have emergency contact units – they push the button and they get help, somebody talks to them and sends out an ambulance or assistance if they need it. They're traditionally connected to copper wire telephone lines, and they're switching off the copper lines in the UK. All those units have to be switched over to mobile.

If they want to switch the parking meters over to apps, they have to make sure that all four networks work wherever they have parking.

Capacity problems are huge, and it's all day long. As soon as people wake up in the morning, until they go to bed at night, there are capacity problems in certain residential areas. So picking a SIM card for the council workers is a big deal, because there's no point in picking a SIM that has the most capacity problems.

PC Pro: Do the mobile networks actually make improvements in the areas you've discovered are poorly served?

We're a source of truth that nobody can deny. And then when the councils go to the operators with our data, they go, "okay, you know what we know now, so let's sit down and talk seriously about it". Before that, they would just bring up the Ofcom maps and say, "look, you have coverage all over the town".

Now we're saying, this is not a coverage problem. It's a capacity problem.

PC Pro: From a regulation point of view, Ofcom still largely focuses on coverage rather than throughput. Do you think that there needs to be a shift there, too?

Philip Maguire: Ofcom has focused on coverage because that's what it gets from the operators. There haven't been capacity measurements and data speed measurements comprehensively done and independently done.

I can show you maps of the overall network performance over a 24-hour period, and it will be mostly green, maybe a few orange spots, but very few red ones. I show you that [same map] between three o'clock and six o'clock in the afternoon, it will be nearly all red.

Ofcom doesn't have that kind of data. Crowdsourcing doesn't, from what I know, give you that kind of data. We do time-of-day analysis on our data, so we know exactly when the problems are occurring, and we always make sure when we're covering areas that we find out when the peak times are in the network and cover them at those times.

PC Pro: How can operators improve throughput? Is it simply a case of putting more masts in?

Philip Maguire: These problems are multifaceted. In really high footfall areas, you can't put in big masts in the middle of the street.

They can put in rooftop masts sometimes, if they can get a host property. This is one of the places where the councils come in. The councils generally have a lot of property around town centres and they can make these available for rooftop masts. Sometimes a small cell will fix the problem.

A great analogy was given to me some time ago. Rooftop masts are like lighthouses – they light up the whole general area, but there's nooks and crannies because of building blockages, where you need small cells to light those up. More like a torch or a street lamp. So, you need both. ●

WHAT OFCOM'S FIGURES SAY...

As noted in the interview, Ofcom tends to focus on coverage rather than capacity. But even if you focus on coverage alone, it's hardly a glowing picture, particularly when it comes to 5G.

Oddly, Ofcom's Connected Nations report uses different metrics to measure 4G and 5G coverage: 99% of UK premises have outdoor coverage on 4G, according to the report, although when you look at geographic areas rather than premises, only 88-90% of the UK is covered by multiple operators.

On 5G, which began rolling out back in 2019, the coverage is much more sparse. Only 22-24% of UK premises are covered by all operators, and that drops to 10-18% in Wales, the worst served nation in the UK. Geographic 5G coverage from at least one operator is at 62% UK-wide, although only 34% of Scotland is served.

ABOVE Would it be unfair to rename Ofcom's report "Not So Connected Nations"?

The A-List

The best products on the market, as picked by our editors

PC PRO A-LIST

PREMIUM LAPTOPS

Apple MacBook Pro M4

M4 beast from £1,599

from apple.com/uk

This M4 update to the already brilliant MacBook Pro line is an easy recommendation, so the big question becomes do you choose the 14in version from £1,599 or 16in from £2,499? And then how much do you upgrade, as Apple isn't afraid of high prices. But whatever you choose should last for years, and look great while it's doing it.
REVIEW **Issue 364, p50**

NEW ENTRY

Apple MacBook Air M4

If you don't need the all-out power of the Pro, this is a brilliant, cheaper alternative despite the unchanged chassis and screen. **13in from £999, 15in from £1,199 from apple.com/uk**
REVIEW **Issue 368, p54**

Honor MagicBook Art 14 (2025)

This slim 1kg laptop packs Intel's powerful Core Ultra 7 255H and a gorgeous 14.6in OLED touchscreen, yet survived for 12 hours in our light-use tests. And it looks gorgeous, too. **£1,500 from honor.com**
REVIEW **Issue 373, p59**

Asus ProArt PX13

With AMD's new Ryzen AI 9 HX 370 inside, this 1.4kg compact powerhouse offers incredible amounts of power. Add a fantastic OLED screen and RTX 4070 graphics and it's a winner. **From £2,000 from uk.store.asus.com**
REVIEW **Issue 361, p50**

BUSINESS LAPTOPS

Dell Pro 13 Premium

Sheer quality from £1,452 exc VAT

from dell.com

Dell's business laptop series has a new name, but its commitment to build quality and astonishing levels of configuration remain the same. Here, you benefit from a 1.1kg weight and 24-hour battery life, with Intel's 200V vPro series there for easier remote management. Just make sure you avoid the cheap screen option.
REVIEW **Issue 368, p46**

Lenovo ThinkPad X1 Carbon Gen 13

The best executive laptop out there, with true all-day battery life even if you buy the 14in OLED version. At 1kg and with the latest components, it's worth the price. **From £1,875 exc VAT from lenovo.com**
REVIEW **Issue 370, p52**

Lenovo ThinkPad T14s Gen 6 (Snapdragon)

There's no better laptop if you want to try out Snapdragon, thanks to its combination of build quality, speed and battery life. **£1,500 exc VAT from lenovo.com**
REVIEW **Issue 360, p56**

HP OmniBook Ultra Flip

A top-quality 2-in-1 with a terrific 14in OLED panel, great build quality and superb battery life thanks to Intel's latest generation Core Ultra 7 processors. **From £1,699 from hp.com**
REVIEW **Issue 365, p46**

CREATIVE & GAMING LAPTOPS

Lenovo Legion Pro 7i Gen 10

RTX 50 power from £2,800

from lenovo.com

A surprisingly elegant chassis considering the power within, even if it still weighs 2.7kg. In return you get a 16in OLED panel, Intel Core Ultra 9 275HX CPU and, in our test system's case, and Nvidia RTX 5080 GPU. Lenovo simply doesn't put a foot wrong.
REVIEW **Issue 370, p75**

Razer Blade 14

Our pick of the 14in gaming laptops thanks to its quiet running, gorgeous design and brilliant OLED panel. And the RTX 5070 graphics makes sense at this size. **RTX 5070, from £2,400 from razer.com**
REVIEW **Issue 372, p58**

Asus ProArt P16 (2025)

Packing a RTX 5070, Ryzen AI 9 and brilliant 16in OLED panel into its slim, 1.9kg chassis, this is a fantastic choice for demanding creatives. **£2,800 from asus.com**
REVIEW **Issue 371, p60**

Asus ROG Strix Scar 18 (2025)

Don't want to make any compromises? Choose this 18in monster, which weighs 3.3kg but extracts every drop from its components. **RTX 5090, £4,700 from asus.com**
REVIEW **Issue 370, p71**

EVERYDAY LAPTOPS

Asus Vivobook S15

Copilot+ PC for £699

from currys.co.uk

This is one of the best-value laptops around, with an eight-core Snapdragon X Plus chip speeding things along in general use – albeit not in games. At 1.4kg it's extremely light for a budget 15.6in laptop and its battery life is excellent too.
REVIEW **Issue 371, p83**

NEW ENTRY

Acer Aspire Vero 16

An eco-friendly laptop due its use of PCR plastics, but more to the point a well-built and powerful 16in laptop that should last for many years. **£999 from currys.co.uk**
REVIEW **Issue 373, p60**

HP OmniBook Ultra 14

If you have £999 to spend, consider the 16GB/512GB version of this cracking machine, with its aluminium chassis, 14in IPS panel and speedy Ryzen AI 365 CPU. **From £999 from hp.com**
REVIEW **Issue 371, p87**

Microsoft Surface Laptop, 13-inch

Another laptop powered by a Snapdragon chip, but it's low power so this stylish laptop is best for less demanding tasks. **From £899 from microsoft.com**
REVIEW **Issue 371, p54**

CHROMEBOOKS

Samsung Galaxy Chromebook Plus (2024)

Core 5 power for £749

from samsung.com

The first truly desirable Chromebook since the Pixelbook, this is a top-quality laptop from the all-metal chassis to the 15.6in Full HD OLED screen. And thanks to Intel's Core 5 120U processor, it's fast enough to last for years.

REVIEW **Issue 364, p65**

Acer Chromebook Plus 516

If you can't afford the 15.6in Samsung Galaxy Chromebook Plus then Acer's Chromebook Plus 516 makes a solid but less beautiful alternative – as reflected in its price. The 15.6in screen provides plenty of space on which to work, and it proved a fast performer in our tests.

From £399 from acer.com

REVIEW **Issue 371, p90**

Acer Chromebook Spin 714

If you're looking for a convertible, this is the best choice around. Others may beat the 12th gen Intel Core i5 we tested for performance, but for features, design and bang for buck you won't find any laptop that can match this 2-in-1 for the money.**£799 from currys.co.uk**

REVIEW **Issue 356, p83**

MINI PCs

Apple Mac mini M4

Little monster from £599

from apple.com/uk

This is a big and timely update for the Mac mini, with a much smaller (and squarer) design that's easy to tuck behind a screen. But what lifts it above the pack is the astonishing power of the M4 and M4 Pro chips, with barely any cooling required. As ever with Apple the upgrade costs are high, but at least its starting price is reasonable.

REVIEW **Issue 364, p44**

Geekom A6 Mini PC

The Geekom A6 Mini PC steals the A8's place on our A List thanks to its sheer value for money. The A6 costs £220 less but doesn't compromise on quality or connectivity, and while the Ryzen 7 6800H is a step down from the Ryzen 9 8945HS in the A8, it remains a superb performer.

£499 from geekom.co.uk

REVIEW **Issue 367, p56**

Minisforum Venus UM790 Pro

Ignore its basic looks, for this compact system packs in a fast AMD Ryzen 9 7940HS processor, 32GB of DDR5-5600 RAM and 1TB SSD along with a generous selection of ports, including two USB-C 4 connectors. And the price is super-aggressive.

£549 from store.minisforum.uk

REVIEW **Issue 363, p91**

ENTHUSIAST PCs

Scan 3XS Edge iCue

Silent but deadly fast for £2,800

from scan.co.uk

With the RTX 5080 comes a refresh of best enthusiast PCs. The Scan is a shade slower than its Ryzen 9 9800X3D rival from Wired2Fire, but even at full pelt it remains astonishingly quiet.

REVIEW **Issue 367, p50**

CyberPower PC Ultra 3D5090

If you're after the fastest gaming PC you can buy for £4,000, let's make things easy for you: buy this. It's packed with speedy components, from AMD's Ryzen 9 9950X3D to RTX 5090 graphics to a 2TB Gen 5 SSD.

£4,000 from tinyurl.com/370cyber

REVIEW **Issue 370, p58**

PCSpecialist Hydra R60S

This compact PC makes little noise but still packs a gaming and creative punch thanks to RTX 4060 graphics and AMD's older but speedy Ryzen 5 7500F. You can upgrade to an RTX 5070 when budget allows. **£999 from pcspecialist.co.uk/reviews**

REVIEW **Issue 368, p60**

ALL-IN-ONE PCs

NEW ENTRY NEW ENTRY

Apple iMac M4

M4 power from £1,299

from apple.com/uk

Anyone hoping for a 27in iMac will be disappointed, but everyone else should be delighted by this M4-powered all-in-one with its 24in 4,480 x 2,520 IPS panel. It's fast inside and out, too, with Thunderbolt 4 and Wi-Fi 6E.

REVIEW **Issue 364, p48**

Dell Inspiron 24 All-in-One

Despite being built to hit a price point, the Inspiron 24 All-in-One manages to look classy, include a good-quality, 1,920 x 1,080 24in panel and have enough power to breeze through a typical day's tasks. It even packs mod cons such as a 720p webcam. Superb value for money.

From £599 from dell.co.uk

REVIEW **Issue 350, p47**

Lenovo Yoga AIO 9i Gen 10

The first all-in-one Copilot+ PC is a superb evolution of Lenovo's gorgeous Yoga AIO 9i, with a 31.5in IPS 4K panel, Intel's "Lunar Lake" Core Ultra 200V processors and gaming prowess via RTX 4050 graphics as an option. **From £1,800 from lenovo.com/uk**

REVIEW **Issue 373, p63**

CREATIVE WORKSTATIONS

NEW ENTRY NEW ENTRY NEW ENTRY

Scan 3XS GWP-A1-TR64

64-core 'ripper for £11,000 exc VAT

from scan.co.uk/3xs

Scan takes advantage of AMD's new 9000-series Ryzen Threadrippers, the 64-core 9980X, to deliver a monster of a workstation that topped almost all of our performance charts. It's helped by an RTX Pro 6000 Blackwell card and 128GB of memory. It's even a quiet runner.

REVIEW **Issue 373, p93**

Armari Magnetar MC64T9

Like Scan, Armari uses the latest AMD Threadripper silicon, this time the 32-core 9970X, to create a truly potent machine – with the assistance of 256GB of DDR5 memory and RTX Pro 600 Blackwell graphics. Simply a great workstation. **£10,995 exc VAT from armari.com**

REVIEW **Issue 373, p90**

Wired2Fire TRX50 Extreme 5090 Workstation

With a free upgrade to a Threadripper 9980X, this is an affordable alternative to the Scan thanks to its consumer RTX 5090 graphics, which has its benefits for certain workflows. 256GB of RAM helps. **£8,333 exc VAT from wired2fire.co.uk**

REVIEW **Issue 373, p94**

TABLETS

Apple iPad Air M3

Languid power from £599

from apple.com/uk

It's hard to be too excited by this update as it's exactly the same design but with an M3 chip inside. But when the original was so damn good, whether in 11in or 13in variants, and Apple Intelligence is thrown in, it remains the best choice for the vast majority of tablet buyers.

REVIEW **Issue 368, p56**

Apple iPad Pro M4

The best tablet in the world becomes even better thanks to Apple's stunning M4 chip, a gorgeous OLED screen and the must-have accessory: the all-new Pencil Pro. But it comes with an obvious downside of cost, with the cheapest 13in incarnation costing £1,299. **From £999 (11in, 256GB) from apple.com**

REVIEW **Issue 358, p48**

OnePlus Pad 3

Not only the best Android tablet you can buy but a genuine rival to the iPads thanks to its support for Apple products via integrated file sharing and a Mac Remote Control feature. It's also fast, packs a superb 13.2in screen and comes with a fine array of accessories. **From £529 from oneplus.com**

REVIEW **Issue 371, p62**

EVERYDAY PHONES

Google Pixel 9a

Why pay more? From £499

from store.google.com

If you can live without an optical zoom then it's hard to think of a reason to pay more for a phone. The AI features are genuinely useful, it's fast, the battery lasts forever, the camera is superb and the 6.3in OLED panel is a joy to gaze at.

REVIEW **Issue 369, p74**

Nothing Phone 3a

Looking to get the best possible phone for around £300? This is it. Quite aside from Nothing's unique design, it features a gorgeous display and high-quality cameras – including an optical zoom that few phones in this price bracket can match.

£329 from nothing.tech

REVIEW **Issue 368, p77**

Honor 400

This is a luxury phone without the luxury price. Taking many cues from the iPhone's design, including its software, the Honor 400 packs a 6.6in AMOLED panel, high-quality 200MP main camera and a mid-range Snapdragon processor. It's great value.

256GB, £400 from honor.com

REVIEW **Issue 371, p72**

PREMIUM PHONES

Samsung Galaxy S25 Ultra

AI in your hand from £1,249

from samsung.com/uk

So good it tempted our reviewer – an iPhone devotee – to move to the other side. That's thanks to the faultless hardware, brilliant photography performance and Samsung's slick AI, not to mention the integrated S Pen stylus. It's not cheap, but you're buying for the long term with seven years of OS updates.

REVIEW **Issue 367, p70**

Samsung Galaxy Z Fold7

The price sticks in our craw and we miss the S Pen support, but Samsung has absolutely nailed the foldable phone at its seventh attempt. It's slim, sturdy, super-fast and it packs cameras so good that – optical zoom aside – this phone's photos are almost inseparable from the S25 Ultra.

256GB, £1,799 from samsung.com

REVIEW **Issue 372, p48**

Apple iPhone 16 Pro

Even without Apple Intelligence, the introduction of a 5x optical zoom, classy 6.3in OLED panel and Apple's ludicrously fast A18 Pro chipset make this the best update to an iPhone Pro for years. And if you need one more reason to buy, how about its much improved battery life? **128GB, £999 from apple.com/uk**

REVIEW **Issue 363, p70**

24IN TO 27IN MONITORS

BenQ DesignVue PD2730S

5K + Thunderbolt, £1,000

from scan.co.uk

A great choice for creative professionals and demanding users alike, and if your budget can take it why not daisy-chain two together over Thunderbolt? You'll love the image quality and 5K resolution.

REVIEW **Issue 372, p89**

Asus ZenScreen Smart Monitor MS27UC

This stylish 27in monitor packs a high-quality 4K screen, but where it distinguishes itself is by loading Google TV and great speakers to turn it into a great choice for those who need to work and play. **£399 from argos.co.uk**

REVIEW **Issue 372, p88**

Iiyama ProLite XUB2797QSNP-B1

This 1440p monitor may lack the luxuries of its A-List brethren, but you can't argue with the quality of the panel, nor the connectivity – with an RJ45 port, this is a true docking monitor.

£237 from iiyama-monitors.co.uk

REVIEW **Issue 372, p84**

32IN+ MONITORS

Iiyama ProLite XCB3497WQSNPH

Curved quality, £380

from scan.co.uk

All three displays here use curved 34in panels with a 3,440 x 1,440 resolution. Despite an aggressive price the ProLite packs everything you need including RJ45 networking and a KVM.

REVIEW **Issue 372, p93**

MSI Modern MD342CQPW

You won't find RJ45 networking here – as expected to hit the bargain price – and others go brighter, but this 34in curved, white monitor delivers terrific colour coverage, a decent pair of speakers and USB-C docking in a stylish casing.

£299 from currys.co.uk

REVIEW **Issue 372, p91**

Philips 34B2U6603CH

This monitor packs in every feature we can think of: Thunderbolt 4, daisy-chaining, excellent 5W speakers, 2.5GbE networking and a high-quality webcam. The cheaper ViewSonic VG3457CV beats it for clean whites, but the Philips is a better all-rounder.

£559 from uk.insight.com

REVIEW **Issue 372, p92**

WEBCAMS

Logitech MX Brio 705 for Business

Consistent brilliance for £219

from logitech.com

Consistent image quality in all lighting conditions coupled with top build quality and nifty features – such as a presenting mode for items on your desk – make this a fantastic all-round choice.
REVIEW **Issue 356, p68**

Logitech Brio 105 for Business

While you can buy 1080p webcams for a third of the Brio 105's price, they won't hold a candle to the Logitech webcam's quality – especially in low-light conditions, such as one candle. It's also easy to manage, for businesses and individuals.
£45 from logitech.com
REVIEW **Issue 360, p77**

Obsbot Tiny 2

This portable 4K webcam delivers for quality, design and sharpness, and it comes with a shedload of advanced features, including dynamic zoom and subject tracking. The only real downside is that it has a price that reflects its premium ambitions.
£329 from amazon.co.uk
REVIEW **Issue 352, p75**

HOME OFFICE PRINTERS

HP OfficeJet Pro 9135e

Do-it-all inkjet for £193

from printerbase.co.uk

This versatile inkjet all-in-one – which includes a 35-page ADF – pumps out high-quality prints at laser-rivalling speeds. Likewise scans and copies. Print costs are reasonable, too.
REVIEW **Issue 365, p85**

Epson EcoTank ET-2865

As usual with ink tank printers, you don't get many frills with the Epson EcoTank ET-2865 (so no ADF or screen). What you do get is incredibly low running costs of 0.5p for colour and 0.2p for mono, plus high-quality prints and scans.
£233 from uk.insight.com
REVIEW **Issue 365, p84**

Canon i-Sensys LBP243dw

Everything you could want from a mono laser printer – it doesn't come with a scanner – the LBP243dw produces excellent results at speed. You also get Wi-Fi and wired networking. **£186 from printerbase.co.uk**
REVIEW **Issue 365, p88**

WORKGROUP PRINTERS

Canon Maxify GX6550

Ink tank all-in-one for £392 exc VAT

from canon.co.uk

Designed to fit in tight spaces, this all-in-one includes a highly effective ADF and backs it up with high-quality prints at 24ipm in our tests. Running costs are superb, too.
REVIEW **Issue 350, p58**

Brother HL-L9430CDN

This laser printer (not an all-in-one, so there's no scanning or copying functionality) is a great choice for a busy office, producing sharp black text and making a good job of colour graphics as well. All while doing so quickly with a competitive price per page. **£415 exc VAT from printerland.co.uk**
REVIEW **Issue 353, p84**

Xerox B315DN

A fine alternative to the Brother and Canon, this mono laser multifunction printer produces superb results at great speed – 27.5 pages per minute in our 50-page test, which includes the spool time. It's similarly quick for scans, with a dual-CIS ADF to speed up double-sided copies. **£238 exc VAT from printerbase.co.uk**
REVIEW **Issue 341, p87**

WIRELESS ROUTERS

Netgear Nighthawk RAXE300

Fast Wi-Fi 6E router, £350

from amazon.co.uk

The RAXE500 is faster than the RAXE300, but in practice we doubt you would notice – this tri-band router still delivered speeds between 50MB/sec and 150MB/sec in our tests. And it's packed with features, too. At £150 cheaper than its bigger brother, we think it hits the Wi-Fi 6E sweet spot.
REVIEW **Issue 341, p68**

TP-Link Archer BE550

At almost half the price of the Netgear Nighthawk RAXE300, this is a brilliant mid-range choice thanks to a 6GHz radio and five 2.5GbE ports – you'll enjoy superb wired and wireless performance, and it even comes with a wide set of features. **£180 from amazon.co.uk**
REVIEW **Issue 371, p70**

Asus RT-BE58U

A great deal for those on a tight budget, this dual-band Wi-Fi 7 router (there's no 6GHz radio) performed well in our 5GHz tests at a price that can't be beaten. You can even enable MLO across the 2.4GHz and 5GHz bands.
£99 from amazon.co.uk
REVIEW **Issue 371, p70**

MESH WI-FI

TP-Link Deco XE200

Clever Wi-Fi 6E for £400

from amazon.co.uk

There are cheaper Wi-Fi 6E meshes, but the XE200 wins for its superb download speeds, excellent coverage and the fact that older clients reap benefits of 6E, not just new ones. And a two-pack (code BOBKTDPWC8) should be enough for most premises.
REVIEW **Issue 349, p65**

Netgear Orbi 770

If you're eager to upgrade to Wi-Fi 7 then the Orbi 770 is the best mesh option yet. Its speed and range are both excellent, with a twin-pack covering 420m² (says Netgear), and the wired connectivity superb: four 2.5GbE connectors on the router unit, two 2.5GbE ports on the satellites. But it ain't cheap. **2-pack, £600 from amazon.co.uk**
REVIEW **Issue 364, p70**

Linksys Velop Pro 6E

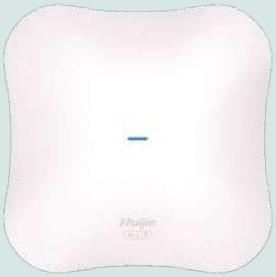
Ironically, this Wi-Fi 6E router will get the most out of your non-Wi-Fi 6 devices thanks to its use of the 6GHz network for station-to-station traffic. And you only need two units for rock solid performance across a three-bedroom house. **2-pack, £380 from amazon.co.uk**
REVIEW **Issue 350, p54**

BUSINESS WI-FI

Ruijie Reyee RG-RAP73Pro

Wi-Fi 7 AP, £201 exc VAT

from broadbandbuyer.com



The RG-RAP73Pro delivers a wealth of features and top Wi-Fi 7 performance at a tempting price. Broadbandbuyer's provisioning service makes light work of deployment, and the free Ruijie Cloud service offers top-notch remote management.
REVIEW **Issue 369, p103**

TP-Link DR3650v

"Business Wi-Fi" doesn't do justice to this all-in-one communications, security and networking solution, which combines a dual-band AX3000 access point with WAN redundancy, failover services and a treasure trove of features. **£208 exc VAT from broadbandbuyer.com**
REVIEW **Issue 368, p103**

DrayTek VigorAP 905

The VigorAP 905 is ideal for businesses seeking a well-endowed Wi-Fi 6 AP with top-notch wireless meshing support. It's a breeze to deploy, wireless performance is good, and a price of only £83 makes it outstanding value. **£83 exc VAT from broadbandbuyer.com**
REVIEW **Issue 372, p102**

NAS SERVERS

Synology DiskStation DS1823xs+

10GbE NAS, £1,413 exc VAT

from broadbandbuyer.com

This stalwart retains its top spot on the A-List thanks to its powerful performance (courtesy of a Ryzen chip), huge capacity via eight LFF/SFF hot-swap SATA bays and an unmatched set of business-friendly apps. And it's all built on Synology's DSM 7.2, which is focused on data security.
REVIEW **Issue 368, p99**

Asustor Nimbustor 4 Gen2 AS5404T

Built for SMBs and enthusiasts who demand the best performance, the AS5404T is a four-bay NAS that offers much more than most, with some nice surprises under its standard-looking exterior.
£441 (£529 inc VAT) from amazon.co.uk
REVIEW **Issue 369, p88**

Qnap TS-264

The Qnap TS-264 is aimed at those who want a bit more from a traditional two-bay NAS. It's effectively the two-bay version of the excellent four-bay TS-464, and like its sibling provides strong speeds over its pair of 2.5GbE ports – and includes two M.2 NVMe slots.
£391 (£469 inc VAT) from ukstore.qnap.com
REVIEW **Issue 369, p86**

VIDEOCONFERENCING

Biamp Parlé VBC 2800

Go big for £2,918 exc VAT (MSRP)

from midwich.com

We thought the VBC 2500 was a great VC room bar, and the new VBC 2800 delivers Biamp's undeniable expertise to larger meeting rooms. Video and audio quality are outstanding, speaker framing is super fast and the smart combination of dual camera lenses makes sure everyone is in the big picture.
REVIEW **Issue 364, p98**

Owl Labs Medium Room Solution

The Owl 4+ and Owl Bar partnership offers smart tracking and dynamic split-screen views to ensure everyone is in the picture, while the Whiteboard Owl adds extra professionalism to presentations and training sessions.
Owl 4+, Owl Bar, TV mount, £2,999 exc VAT from owllabs.co.uk
REVIEW **Issue 364, p100**

Ricoh Meeting 360

Ricoh's Meeting 360 is up against stiff competition in the panoramic meeting hub market but stands out for its excellent build quality and generous three-year warranty. It's easy to use and delivers good video and audio quality, while the smart app allows you to create a view for every occasion.
£744 exc VAT from amazon.co.uk
REVIEW **Issue 364, p101**

SCANNERS

Brother ADS-4900W

60ppm for £529 exc VAT

from tradescanners.com

An incredible range of features at a competitive price. Scan speeds are even faster than the quoted 60ppm, output quality is excellent and top-notch software and apps deliver a wealth of options.
REVIEW **Issue 370, p98**

Ricoh fi-8040

Ricoh's fi-8040 offers SMBs a remarkable range of features for a great price. Output quality is beyond reproach, it delivers on its 40ppm promises and the multiple operational modes make it highly flexible. **£249 exc VAT from thescannershop.com**
REVIEW **Issue 370, p101**

Canon imageFormula DR-S350NW

You don't need to install this affordable networked desktop scanner, which almost hit 55ppm scan speeds in our test. Canon backs it up with a fine software package. **£433 exc VAT from printerland.co.uk**
REVIEW **Issue 370, p99**

SECURITY APPLIANCES

DrayTek Vigor C510ax

Unbeatable redundancy for £447 exc VAT

from broadbandbuyer.com

Ideal for SMEs and remote sites that need always-on internet access. It's packed with WAN redundancy features, the latest DrayOS 5 software delivers a wealth of features, and it all comes at a great price.
REVIEW **Issue 372, p99**

Zyxel USG Flex 50HP

Don't be fooled by its size: Zyxel's USG Flex 50HP packs in an impressive set of security services for the price. It's ideal for protecting small offices and remote sites, and the slick Smart Sync feature means never having to choose between local or cloud management.
Appliance with 1yr Gold licence, £316 exc VAT from store.zyxel.com
REVIEW **Issue 372, p101**

WatchGuard Firebox T85-PoE

A powerful gateway security package ideally suited to protecting large remote sites. Licensing schemes are easy to understand, and WatchGuard's cloud portal makes light work of remote management. **Appliance with 3yr TSS subscription, £4,284 exc VAT from broadbandbuyer.com**
REVIEW **Issue 372, p100**

SECURITY SOFTWARE

Avira Prime
Avira wins for all-round AV performance, plus a solid VPN, for a fair price. Watch out for a second-year hike to £91, though. **First year: 5 devices, £52 from avira.com**
REVIEW **Issue 366, p84**

Bitdefender Total Security
A long-term award winner in our security suite Labs, Bitdefender continues to charm for its consistent AV performance, solid feature set and extremely competitive price. **5 devices, 1yr, £20 from store.pcpro.co.uk**
REVIEW **Issue 366, p85**

Avira Free Antivirus
There's absolutely no need to pay for a full security suite if you only want antivirus protection, and Avira is our top choice simply due to its excellent and consistent performance in tests. **Free from avira.com**
REVIEW **Issue 366, p89**

VPNs

ExpressVPN
Blistering speeds, outstanding region-shifting performance and a good track record on security mean this VPN is worth the expense. **2yr 4mth $140 (£113) from expressvpn.com**
REVIEW **Issue 370, p84**

Mullvad
A consistent performer with consistent pricing – there's no need to sign up for the long term as it costs only €5 per month as a flat rate – but not the best choice for region shifting. **€5 (£4.34) per month from mullvad.net**
REVIEW **Issue 370, p85**

Proton VPN Free
While Proton's VPN Plus is also a great choice, if you're looking for a freebie then choose this VPN for its fast connections (or alternatively Windscribe if you need to choose territories). **Free from protonvpn.com**
REVIEW **Issue 370, p89**

LINUX DISTROS

Ubuntu
A fine choice for Windows switchers thanks to its familiar design, with regular six-monthly updates and a Long Term Support version. **Free from ubuntu.com**
REVIEW **Issue 367, p92**

Fedora Workstation
One of the longest-established distros, and with a strong link to Red Hat Enterprise Linux, Fedora Workstation will particularly appeal to business migrators. **Free from fedoraproject.org**
REVIEW **Issue 367, p85**

Linux Mint
There's a good reason this is a popular choice for Windows 10 refugees, including a familiar "Start menu", and it's easy to give it a trial before committing. But consider Zorin OS, too. **Free from linuxmint.com**
REVIEW **Issue 367, p86**

CLOUD BACKUP

IDrive Business
An incredibly affordable hybrid backup solution. It's easy to deploy, supports Google Workspace, Microsoft 365, Dropbox and Box, and is ideal for protecting remote and on-premises systems. **5TB, £791 exc VAT per year from idrive.com**
REVIEW **Issue 371, p100**

Barracuda Backup Vx
This affordable virtualised on-premises backup solution is easy to deploy on VMware or Hyper-V hosts and integrates local and cloud backup. **From £804 exc VAT per year from barracuda.com**
REVIEW **Issue 371, p99**

NETWORK MONITORING

Progress WhatsUp Gold 2024
A great SMB choice as it presents a clear picture of your network and is available in a wide range of licensing plans. It's a cinch to deploy, doesn't require a lot of host resources and the new features make it even easier to customise. **Enterprise, 50 devices, £1,177 exc VAT per year from whatsupgold.com**
REVIEW **Issue 366, p100**

Park Place Technologies Entuity 22
An impressive toolbox of monitoring services all easily managed from a web console that offers a wide range of informative dashboards. **From $150 per node/year from parkplacetechnologies.com**
REVIEW **Issue 366, p99**

VOIP SERVICES

3CX Phone System 20 Update 5
Deployment options are extensive, call-handling features are excellent and, although you'll need to source a SIP trunk, it's incredibly affordable. **Enterprise, 8SC, £385 exc VAT per year from 3cx.com**
REVIEW **Issue 369, p98**

TelephoneSystems.Cloud
Ideal for businesses that don't want any unpleasant billing surprises, with an impressive range of call-handling features. **From £11 exc VAT per user per month from telephonesystems.cloud**
REVIEW **Issue 369, p100**

ENDPOINT PROTECTION

WithSecure Elements Endpoint Security
A comprehensive set of protection measures for a great price, easily managed from a cloud portal. It supports a wide range of devices and the Luminen tool delivers AI-powered reporting services that present detailed summaries of events with a click. **100-499 devices, £37 exc VAT each per year from withsecure.com**
REVIEW **Issue 363, p101**

Sophos Intercept X Advanced
An unbeatable range of tough security measures. Deployment is a breeze, and a multitude of security policies make it highly flexible. **100-199 users, £48 exc VAT each per year from enterpriseav.co.uk**
REVIEW **Issue 363, p98**

REMOTE SUPPORT

NEW ENTRY

IDrive RemotePC Enterprise
Large businesses that want a flexible and feature-rich cloud-hosted support solution will love RemotePC Enterprise. It provides technicians with a wealth of support tools, access security is tight, and IDrive's simple licensing plans are superb value. **First year, 100 PCs, £329 exc VAT from remotepc.com**
REVIEW **Issue 373, p99**

NEW ENTRY

Zoho Assist Professional
Assist lives up to its name: it's easy to use and manage, offers a wealth of support features, and licensing plans are flexible. **£12 exc VAT per month/technician billed yearly from zoho.com/assist**
REVIEW **Issue 373, p101**

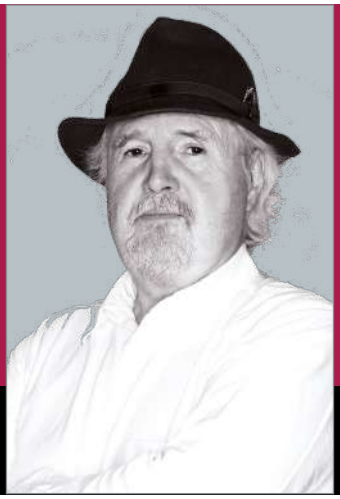
CLOUD FILE-SHARING

Progress ShareFile Premium
Progress ShareFile Premium will appeal to SMBs seeking affordable and easily managed cloud collaboration services. It offers plenty of app integrations plus support for large file sizes, and the AI-powered features deliver smart security measures. **£19.90 exc VAT per user per month billed yearly from sharefile.com**
REVIEW **Issue 367, p98**

Dropbox Business Plus
Collaboration tools, app integrations and a huge maximum file size limit – plus malware scanning and data classification – make this a great choice. **£18 exc VAT per user/month billed yearly from dropbox.com**
REVIEW **Issue 367, p96**

The PC will never be collectable

While many items of 1980s and 1990s culture have become valuable assets beloved of collectors, PCs and their cousins are never quite as coveted



Dick Pountain is editorial fellow of *PC Pro*. He will hold onto the drawer containing *every* Psion Organiser, so don't even ask. dickpountain.co.uk

I don't really have the collector's instinct. When I was a kid my father was a serious stamp collector, and I briefly made a feeble effort to become one too. I was slightly more interested in my album of labels from exotic canned goods, but that soon petered out. In adulthood I've accumulated nine guitars but each of those was bought to play, then superseded but not sold, so it doesn't really count as a collection. I have owned ten motorcycles over 60 or so years, but only ever one at a time. Books don't count: I started accumulating those as a student and continued as a book reviewer, but all were obtained to read and never sold (there are around a thousand of them, none rare).

When I'm not writing about computers here, I review books for a political journal, mainly ones about political economy and sociology. An author who had a big influence on me was the French sociologist Pierre Bourdieu, whose best-known book *Distinction: A Social Critique of the Judgement of Taste* examined taste as an act of social status building, drawing on huge amounts of data gleaned from quantitative surveys, photographs and interviews.

Two former associates of Bourdieu, Luc Boltanski and Arnaud Esquerre, published a 2014 paper called "The Economic Life of Things: Commodities, Collectibles, Assets", which is the best, most interesting account of collectability I've seen. The authors describe the way that all the things we manufacture, purchase and use pass through three phases of ownership, which they label the "standard form", the "collectible form" and the "asset form".

Consider a lemonade bottle from before the First World War with one of those stoppers that's a caged glass marble. A mass-produced item, made as cheaply as possible, reusable and returnable for a penny. It served its purpose of containing and dispensing lemonade, then eventually got thrown in the bin (standard form). Years later someone found it in a tip; it ended up in an antique shop, sold for £15 to a middle-class couple as a kitchen ornament (collectible form). Their friend was a famous film director and it became a key prop in a very successful movie, and ended up sold for £5,000 in a sale of memorabilia at Christie's (asset form).

An ancient Roman olive-oil jar might follow a comparable trajectory, with prices several orders of magnitude higher. A drawing done on a napkin to pay for supper by a famous painter ditto, but its asset form might be in millions. In the asset form, things are no longer used, may often not even be displayed but stored in a vault, a hedge against inflation or financial crisis, a store of value.

> "The aesthetic appearance and quality of workmanship of computers is so low that few people want to collect them"

What has this got to do with computers, you may be wondering. Well, nothing actually, and that's the point. Computers, along with much of the rest of the merchandise of the digital world, seem to defy the three-phase classification scheme by being stuck forever in the standard form: they end up in a skip, then get ripped apart to recycle a few chips and some gold-plating. The aesthetic appearance and quality of workmanship of such goods is so low that very few people want to collect them, and what's more those few who do face insurmountable problems in keeping them working, due to the rapid and haphazard evolution of firmware, software, ports and storage media, plus the lack of effective documentation, and the rapid disappearance of smaller manufacturers prior to the monopoly era we now inhabit.

> "I have a room full of digital junk that I can't get rid of. Digital junk that those nearest and dearest to me would love to see dumped in a skip"

If you think you can detect a faint tinge of animus in that last paragraph, you're correct. I have a room upstairs full of digital junk accumulated over my 40+ years of computer journalism that I can't get rid of. Digital junk that those nearest and dearest to me would love to see dumped in a skip to reclaim the room. I can't bring myself to do that. Along with some quite notable historic hardware – first-gen IBM PC and Macintosh, Acorn Archimedes, NewBrain, Epson HX20 – there are shelves full of software both famous and obscure that I have a hunch I may perhaps be the only person to still have, given my privileged status as recipient of review materials.

The early history of the UK personal computer scene is sitting up there, and no-one appears to want it. I've tried all the various computer museums people have recommended, and none is interested in collecting the lot (I no longer have a car). All the reasons I mentioned above render it enormously hard for them to get this stuff working, and once they do it's hardly entertaining. I do feel, though, that someone ought to document this history before skips claim it all.

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Tech firms need to remember that people are bad

Algorithms and tech systems fail to consider the real world and the people in it, including the residents of London

Nicole Kobie is *PC Pro*'s Futures editor. She loves living in London. Everyone is bonkers, so she fits in.
@njkobie

Technology developers live and breathe in blocks world. This isn't an insult – though they often behave like block heads – nor is it a weird reference to *Minecraft*.

Blocks world refers to the simplified environments created by technology developers to test their ideas. Back in 1991, Rodney Brooks went viral – or whatever it was called back then – for his paper "Intelligence Without Representation" that criticised the way robotics et al were stuck in blocks worlds rather than being developed to work in the real world.

AI and related technologies required "experiments with real creatures in real worlds" he said, to see if they really worked. (He went on to co-found iRobot, which made Roombas a common household item, so he was certainly correct about a lot of things.)

Blocks worlds persist in innovation. Whenever new technology is rolled out in the real world, the creators seem to forget that humans exist – even though the products are usually designed to interface with us meat bags.

Take Lime bikes. The beep-beep-beep made by a "hacked" or stolen Lime bike has been dubbed the soundtrack to summer in London. The noise was clearly designed to be a deterrent but appears to be a badge of honour for some – and the green-and-white bikes end up dumped in our local canal.

> "Before tech lands in the real world, companies need to remember that people will poke holes in everything"

Such schemes are a remarkable mix of technology: connectivity, GPS and apps mean you can get a bike anywhere. But no matter how smart your tech, if you leave bikes around London, people will use them in creative and terrible ways. This is just the way of things.

Need I mention Tesla cars? You have to keep your hands on the wheel, and the firm wisely built in technologies such as a weight sensor in the seat to ensure people do – except that's easily dodged and there's plenty of dashcam footage on YouTube to prove it. What did Tesla think, people would behave? Given the leadership of that company, you'd think it would know better.

Then there's Uber. A report in the *New York Times* revealed real problems in how the firm deals with sexual harassment and assault – issues previously raised in London, leading to Uber's licence being revoked temporarily. The latest details out of the US are damning: reports of harassment going uninvestigated and even sexual assaults of female riders. (Uber denies much of the reporting.)

Letting anybody, after basic checks, pick up women and other vulnerable people was always going to cause a problem. And while no cab company is immune from such concerns, the scale here is astounding: 400,000 incidents annually in the US.

These examples prove inherent weaknesses in us humans and aren't the fault of the firms themselves. But when you design tech that removes humans from a situation – which is what automation does – it's vital to remember that humans are still involved, and will therefore need consideration and protection, be it from themselves or others.

Renting a bike from a shop is less convenient than Lime, but with a person managing the interaction, it's harder for mass theft to be a problem. Put automation in cars and we'll push it, test it, rely on it – research has shown this time and time again. Cut regulations and remove employee oversight from taxi companies, and dodgy drivers slip through the net. Put simply, automation has downsides.

Being tech firms, they try to address these challenges with, yes, automation. But even kids get past the anti-theft functions on Limes, drivers put heavy bags in Tesla front seats, and Uber's safety alerts failed to interrupt attacks.

The real world has something else that blocks world lacks: repercussions, from regulators and lawsuits. Hounslow Council has banned Lime bikes in favour of other providers, tired of pavement congestion caused by bad parking. Tesla was found partially liable for a horrific traffic fatality and ordered to pay $200 million. In 2019, Uber was slapped down by Transport for London – and after that report in the US, hopefully it will face similar regulatory attention on those shores.

> "No matter how smart your tech, if you leave bikes around London, people will use them in creative and terrible ways. This is just the way of things"

Before tech lands in the real world, companies need to remember that people will poke holes in everything. Waymo-style driverless cabs are set to hit UK streets in the future. How will operators prevent human-caused incidents? Imagine going for a ride only to have the car stop because bored teenagers ran out in front of it. And what do you do if they won't move?

Remember delivery robots? They've so far been trialled unscathed on university campuses and in parts of Cambridge. I can tell you what will happen if anyone sends them to north London: they'll end up drowned in a canal alongside the Limes.

Before tech leaves blocks world, developers need to remember that not everyone is as nice as them. The real world is a lot weirder than labs.

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Don't blame the AI messenger

Barry Collins is available for meetings between 7pm and 10pm on Fridays and Saturdays, chiefly in the pub. Book in with his AI assistant at barry@mediabc.co.uk. @bazzacollins

Some bosses want to ban AI assistants during meetings, but their presence makes us all better and more attentive attendees

One of the many things I don't miss about working in an office is the meetings. When I edited *PC Pro*, at least half my day was spent in meeting rooms. Meetings with my publisher, my team, the ads team, marketing, subscriptions, press briefings. I once had a meeting where the athlete Roger Black brought doughnuts to my desk. This was the point I decided to give up drinking.

That was getting on for 15 years ago. Nowadays, you're probably not shuttling from one glass cubicle to another, but sat in front of your screen, jockeying between Teams, Zoom and Google Meet. Maybe a Slack Huddle or two in between. You don't have to make polite conversation by the watercooler or loom like Reggie Kray at the door to hurry up an over-running meeting in your booked room, but the meetings drain is still real. It's just moved online.

Little wonder, then, that people are increasingly tempted to send an AI proxy to their meetings. Services such as Otter, Teams and Google all allow you to log into a meeting, switch off the camera and have an AI assistant transcribe the meeting, delivering a summary of all the key takeaways and action points once it's over. Why bother going at all?

Otter.ai plans to take this even further. It already allows you to have an AI assistant sit in on your behalf, able to field questions. And before long, the company hopes the AI will be capable of interjecting by itself, because of the knowledge it's garnered from sitting in on all your company's meetings. None of the bags of atoms in the meeting can remember what the Q4 advertising budget was? Otter's AI should be able to pipe up with the answer.

Of course, the backlash has started. Hand-wringing pieces lamenting the fact that people are turning up for online meetings to find they're the only human in the room. I attended a meeting recently where the host demanded all AI assistants be switched off, so that "I have your full attention". This person clearly missed their calling as a primary school teacher.

> "The irony is that, without my AI assistant, they probably got less attention than they would otherwise"

The irony is that, without my AI assistant, they probably got less attention than they would otherwise. Otter.ai allows me to be *more* present in meetings, not less.

My shorthand was never very good; now it's about as readable as the leaflet they put in packets of paracetamol. When I'm scribbling notes in briefings or meetings, I'm not really paying attention to what's being said, I'm trying to remember what was said ten seconds ago and get it down before I forget. Because, as I edge recklessly closer to what the Sunday supplements insist on calling "middle-aged", my memory is about as reliable as West Ham's back four.

With Otter.ai in a meeting, I need not fret about jotting down important information. I can see it's taking down everything said in the meeting, as the transcription streams across my screen like the *Grandstand* vidiprinter while someone is talking. It records the audio, in case the transcription falters or I need to go back and check something later. And at the end of the meeting I'll not only have a superbly formatted summary of the discussion, but be able to ask the AI questions about what was said. It means I can engage fully in the meeting, not be constantly scribbling away, only half-conscious of what's just been said.

> "When people moan about new-fangled AI assistants in meetings they're really moaning about centuries-old human failings"

The advent of AI meeting assistants has made me a more active participant, and it's improved the quality of my interviews, because I can think about what question to ask next based on the previous answer, not just blather something out because I'm still jotting down the previous response. It's one reason we now run in-depth and (I hope) interesting Q&As in the news section.

Now, of course there's a flip side to this. If people are using AI assistants as a pure proxy in meetings, those meetings are going to be as much use as Matt Hancock. I can only ever recall doing this once, when I had to rush out of an online meeting to pick up my daughter from school and left the AI assistant running, so I could later catch up on what I missed.

But I wouldn't have the audacity to use an AI stand-in in 99% of meetings I attend, because the whole point of me being in those meetings is that I'm making a contribution. I wouldn't have many clients left if I tried to palm them off on my AI helper, no matter how well it knew my business, because they're paying for me, not a hollow facsimile of me that isn't empowered to make decisions.

So when people moan about new-fangled AI assistants in meetings they're really moaning about centuries-old human failings. Laziness, chiefly. If it makes no difference whether you or your AI assistant attend a meeting, you either shouldn't be in that meeting in the first place, or you're about to be replaced by someone who should.

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Readers' comments

Your views and feedback from email and the web

Extending laptop life

I enjoyed Lee's article "Windows 11: All Your Questions Answered" (*see issue 372, p26*). Here's another suggestion for extending the life of a laptop. Many that cannot move to Windows 11 have a DVD drive. For no more than about £30 you can buy an HDD caddy and SSD that can easily replace the DVD drive.

You can then install another OS such as Linux or even an unsupported copy of Windows 11, leaving your original Windows 10 undisturbed. With two SSDs in the laptop you can make ultra-quick backups and you can always pop the DVD drive back in if needed.

Peter

RIGHT You can put the DVD drive in an old laptop to good use in our main feature about building a PC this month (*see p26*).

P-p-p-pick up a part

I enjoyed your article "Windows 11: All Your Questions Answered". I have been upgrading my desktop PC for many years now, with the most recent upgrade being made to get Windows 11 compatibility.

There's one resource you didn't mention which I've found very useful, namely PCPartPicker (**uk.pcpartpicker.com**). You can put all the parts you need on a build screen, and it will warn you of any potential compatibility issues. Once your build is ready, you can then see where the best prices are available from.

John Gwatkin-Williams

Editor-in-chief Tim Danton replies: Thanks for writing in, John, and you make an excellent point. Luckily we give PCPartPicker plenty of mentions

I don't want to be a hater, but...

Tim Danton put his finger on it with his Microsoft-based leader column in issue 372. When my 2019 27in iMac had slowed to a stop and wasn't financially repairable, I took the plunge and bought a Lenovo ThinkPad 14 (graded but like new) from my local computer shop in Matlock. A very nice machine it is, but Microsoft spoils it by piling on the crud and pre-installed cruft. I've cleaned it up of course, but the process has taught me only to despise it. I can drool over the Mac mini, though, and may yet shell out for one and donate the laptop to my youngest as she starts secondary school. I'll be paying the OneDrive sub, though. They win.

Mike Brooker

Fibre saturation point

The real reason why the full fibre rollout is stalling and delayed until 2032 is that there's way too much competition in place in Britain. As I type this I can see four different fibre networks, leading to the situation where we are over-saturated: all four offerings are within pounds of each other for basically the same quality of service.

There is absolutely no need for this saturation as it would have cost four times the price to install, not to mention the amount of disruption in digging the same pavements four times. In a street of 100 houses you are only going to get 25% of the business on average.

We need to understand that internet provision is now really a must-have utility, just like the old copper network. What would happen if we applied the same idea to other utilities, so that's multiple water pipes, gas pipes and electricity cables?

BT/Openreach should have been given the monopoly to install the UK's fibre utility network, which is really a rewriting of the old copper network, and they could have subcontracted out to other fibre installation companies to do defined areas.

Michael Ashworth

Laplink vs Windows migration

In your September 2025 issue, you show Laplink PC Mover as "free software". There is a big problem here. Laplink itself states (as do you) "Laplink PCmover Express (see p32) is a brilliant way to migrate your PC to Windows 11, but the one thing it can't move is your applications. For that, you need Laplink PCmover Professional 11". So, other than moving from Windows 10 to Windows 11, the software is basically

Star letter

Dead pixels society

Thanks for the review of 22 professional-quality monitors (*see issue 372, p74*). For me there was one glaring omission: not a single mention of dead or bright pixels. Having had many monitors in the past, I have been unlucky enough to have had several with both light and dark pixels. Is this no longer an issue?

Suppliers always seemed to have had a get-out, in that you had to have a certain number (usually quite a lot) of dead pixels before they would even entertain supplying a replacement. If all these screens were pixel perfect, why not tell us?

Buying a new monitor has always been a scary experience for me; switching it on for the first time is an anxious moment. Once you spot the pixel error I've found that no matter what other great features the screen has, it becomes less enjoyable and more irksome to use.

Barry Finlay

Editor-in-chief Tim Danton replies: Thanks for this, Barry, and I'm glad you otherwise found the group test useful. The problem of dead pixels hasn't gone away, although I can't remember the last time I saw one so I confess it isn't something I considered during my tests. Most monitors we review fall under Class II of the ISO 9241-307:2008 standard. This allows for fewer than two bright dots, two dark dots and five sub-pixel defects (a pixel is made up of red, green and blue subpixels) per million pixels. I must admit that I would find that irritating, especially as a 4K display includes over eight million pixels. However, I suspect that most reputable manufacturers would look sympathetically on any claims.

In future tests, I'll make sure to include details of each company's dead pixels policy.

This month's star letter writer wins a Cherry Stream Desktop Comfort keyboard and mouse wireless set, worth £80. For a chance to win, email letters@pcpro.co.uk

useless because it will not migrate your installed applications as well. It's fine to help you move from Windows 10 to Windows 11, but if it won't move your applications as well, and you have to do it manually, reinstalling applications and copying over backed-up data, it is really of no use. Moving from Win10 to Win11 is a no brainer anyway, and PCMover need not be used at all.

Dave Quinn

Editor-in-chief Tim Danton replies: I admit this thought occurred to me as well, and for in-PC migrations there is much to be said for the all-Windows approach. However, Laplink makes it easier to automate much of the process and copes better when moving from 32-bit to 64-bit Windows, while an Undo feature is on hand if something goes wrong. Microsoft, not unusually, tends to keep users in the dark when it grabs all your data, so there are reasons to opt for a specialist – especially when migrating from one PC to another.

Where are the all-in-ones?

For the past couple of months in a row the HP Envy 34 all-in-one PC is featured as a best buy for all-in-ones in your A List. I can't find this PC anywhere and it isn't featured on the HP website, where the largest screen size in the filter is 32in. Can you redirect me?

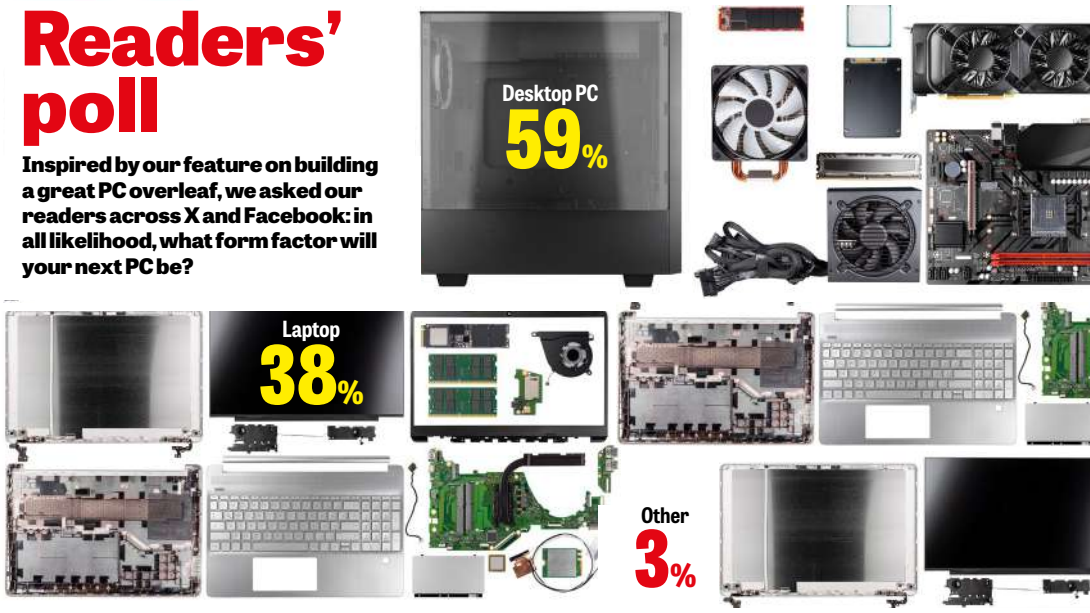
Greg Fattorini

ABOVE Lenovo's excellent Yoga AIO 9i Gen 10 gets the full *PC Pro* treatment on p63

Editor-in-chief Tim Danton replies: Sorry about this, Greg. It turns out that HP quietly discontinued the excellent HP Envy 34 all-in-one, and we're awaiting the equivalent OmniStudio X all-in-one PC (HP has also retired the Envy brand). We will try to cover all the best all-in-one PCs as they appear, but it looks like the new HP line will max out at 32in. The same for Lenovo; we review its latest premium all-in-one PC, the 32in Yoga AIO 9i Gen 10, on p63.

Readers' poll

Inspired by our feature on building a great PC overleaf, we asked our readers across X and Facebook: in all likelihood, what form factor will your next PC be?



Thank you to everyone who replied on Facebook and X. You gave us a brilliant selection of responses and we're sorry we can't print them all. Let's start with some desktop love, as that topped our chart by a distance.

"The need to replace these days is usually due to breakage rather than failure," said Dr Peter Moseley. "Sure, I've had a few PSUs fail, but with storage chip-based these days, I'd need to kick my desktop round the car park to break it! Most basic laptops break like eggs!"

"Most likely a tower PC," agreed Daniel Mackay. "It's like therapy when I build a machine. So satisfying when you hit the power button and it fires up first try." Keith Miller agreed, mentioning that tower PCs are "relatively cheap and easy to build. I can maybe do partial upgrades and expand as I can afford."

Others are preparing to move to laptops. "Next PC will most likely be a laptop," wrote John O'Connell (@endurium on X). "I expect my self-built desktop will be good for at least another six years or so but doubt my Surface Pro 4 will cut it a few years from now."

"Laptop," wrote Adam Jackson. "90% of the time it's on my desk plugged into monitors and hub just like a desktop, but the 10% of use when I'm out and about is too useful to give up."

Then there are the waverers. "I have a new Windows laptop (thanks, *PC Pro* recommendation) and might next succumb to a Mac mini if I can set it relatively easily for biometrics/passkeys," wrote Helen Cleaveland, @HCleaveland on X.

And finally the people who have transcended the world of PCs and laptops altogether. "My PC days are behind me except for one website that won't allow access from my phone," wrote @JohnStanners on X.

We're also intrigued as to what's going through the mind of @Ectopoint. "A desktop plablet tower hybrid mobile workstation with expandable 37in 13K flingerscreen and thoughtwave keyboard. With the internal espresso machine option." We'll take two to go.

> "Can't resist the opportunity to build a new machine when Microsoft stops supporting Win10 for free." @eight_ornine

> "Depends on what's Hot Hardware of the week!" Tom Dickson

> "Desktop: easier to repair and upgradable when that next game wants even more oomph." Tanya Taylor

> "I'd love a desktop again but it'll likely be a laptop as it's more flexible." Stephen Cornish

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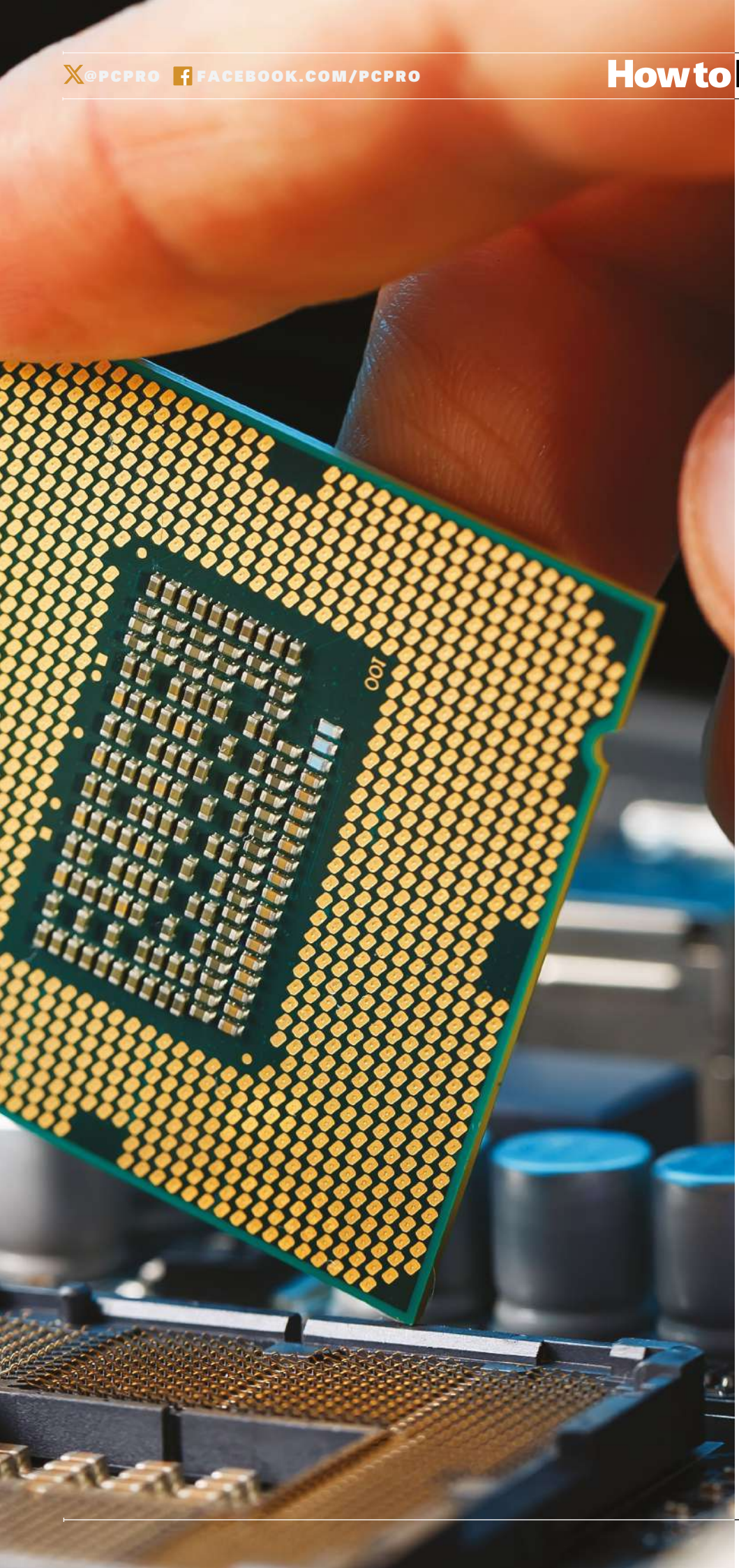
HOW TO BUILD A GREAT PC

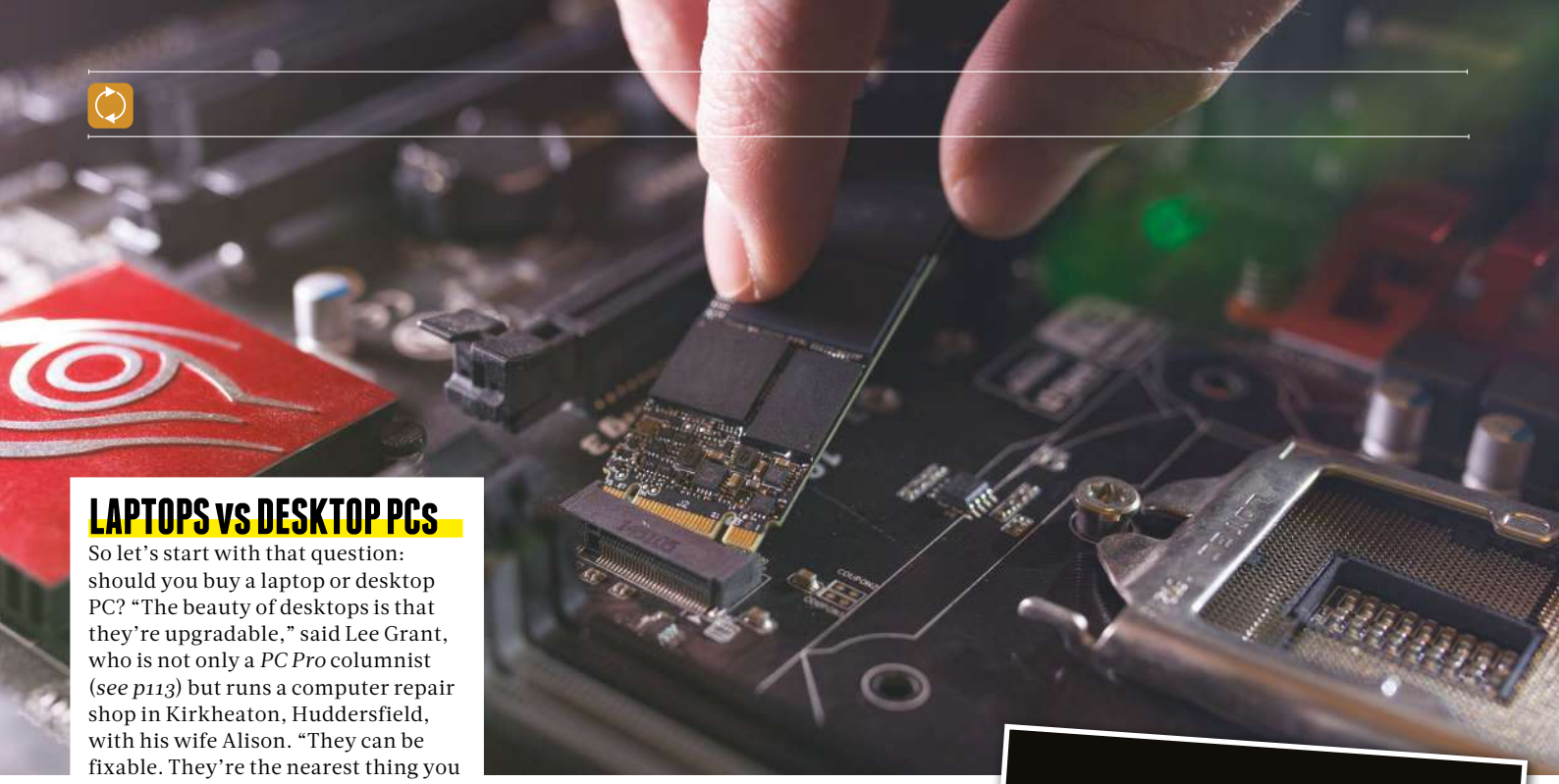
TIM DANTON SPEAKS TO PC-BUILDING EXPERTS TO DISCOVER THEIR TIPS ON CREATING THE BEST POSSIBLE PC FOR YOUR BUDGET, WHETHER BUILDING IT YOURSELF OR CHOOSING ONE FROM BUYERS



Whether you want to buy a new PC or build one yourself, squeezing the most out of your budget is a challenge akin to four-dimensional chess. Every decision you make has repercussions, some of which may not show themselves until three years down the line. This article is here to help. Based on my own 25 years' experience reviewing desktop PCs, responses from PC vendors and an interview with our very own Lee Grant, I aim to cover the big questions, the pitfalls and squeeze in a few handy tips.

While you can visit sites such as PCPartPicker (**pcpartpicker.com**), which is a great starting point as it does an excellent job of ensuring your parts are compatible, this – like all "configure it yourself" systems – assumes you know roughly what you want already. It reduces our game of chess to two simplistic and manageable dimensions, of price and spec, but lacks soul. There's also the very real risk of either under-specifying or over-specifying.

This guide to buying PCs is also a dog-eared love letter to desktop PCs as a whole. Modern laptops pack phenomenal amounts of power into a tiny space, but if you find yourself computing from the same desk 99% of the time then PCs remain the best choice for value and upgrades. Much like Trigger's broom, if you choose wisely they can morph over the years to the point where virtually nothing remains of your original machine.



LAPTOPS vs DESKTOP PCs

So let's start with that question: should you buy a laptop or desktop PC? "The beauty of desktops is that they're upgradable," said Lee Grant, who is not only a *PC Pro* columnist (*see p113*) but runs a computer repair shop in Kirkheaton, Huddersfield, with his wife Alison. "They can be fixable. They're the nearest thing you get to sustainable technology."

Away from games, however, a modern laptop may be just as fast as a desktop PC. In recent years the CPUs inside laptops have caught up with their desktop counterparts to a quite incredible degree, and have actually overtaken them in terms of running AI tasks: there isn't a single desktop chip that meets Microsoft's criterion of including an NPU rated at 40 TOPS. And while you can't fit as much storage into a laptop, which usually has a single socket for SSDs, both desktop PCs and laptops have standardised on the M.2 form factor.

Games are a different matter, as Ben Miles from Wired2Fire points out. "Laptops make for great mobile gaming companions, but the form factor isn't as performant, upgradable or aesthetically striking as a good gaming desktop," he said.

"Mobile versions of CPUs and GPUs have closed the gap compared to desktop variants over the years, but are still hamstrung by power envelopes that get overwhelmed by real-world gaming workloads, even if they can sneak through a typical benchmark run at full speed."

ABOVE The big advantage that desktop PCs have over laptops is that they're upgradable

RIGHT If you're building a gaming rig, it makes sense to spend a lot of your budget on the graphics card

The other key difference is that Nvidia's mobile chips fall a long way short of their desktop equivalents, despite sharing the branding of, say, RTX 5090. "A mobile RTX 5090 is barely as fast as a desktop RTX 5070 Ti," said Ben, "so is quite misleading in terms of its actual positioning in the market. Plus, gaming laptops aren't meaningfully upgradable beyond RAM and storage, and are often loud and uncomfortable to use as a primary gaming device."

BELOW Even the fastest gaming laptop can't keep up with a desktop PC with an RTX 5070 Ti inside

BALANCING ACT

So, let's assume that you're persuaded by Lee and Ben's arguments and that you want to buy a desktop PC. The next big question is how you set about choosing the various components. The processor, the motherboard, the memory, the graphics card, the chassis, the amount of storage?

"The most commonly asked questions we receive are usually regarding what performance [you can get for a budget] on a given game or set list of games, or in relation to streaming or content creation," said Dave Gornall of CyberPowerPC.

"For example: 'I would like to achieve 165Hz at 1440p on *Warzone*, what is the best streaming system you can build for me under £2,000?' Which we would usually ask for more information on other use cases to make sure we're checking all of the boxes, before offering a selection of different specifications within the budget (for example, an AMD CPU spec, an Intel CPU spec, both short of and at the higher end of the budget)."

Ben gave a similar reply. "Our most often asked question is 'what do I need to run X smoothly?', where X could be any game, application or simulation the customer is passionate about. It's very easy to spend money unwisely on PCs and end up with a spec that is grossly over-specified in the wrong area. A 64-core Threadripper, for example, might be incredible for video encoding, but is bested by a simple Ryzen 7 costing 90% less money for gaming.

"The key is balance," he continued. "If you overcook one component at the expense of another, you'll end up with a bottleneck in the usability and overall performance of the device. Wired2Fire would never, for example, couple a Ryzen 9 or Core Ultra 9 CPU with an entry-level motherboard, as the power phases in the board would be overwhelmed and aggressively throttle the clock frequency." For the sake of balance, I should point out that I'd be shocked if any reputable PC manufacturer did this. "Likewise, you can totally hobble the performance of a powerful GPU if the CPU, RAM or cooling is not up to the standards set by that component."

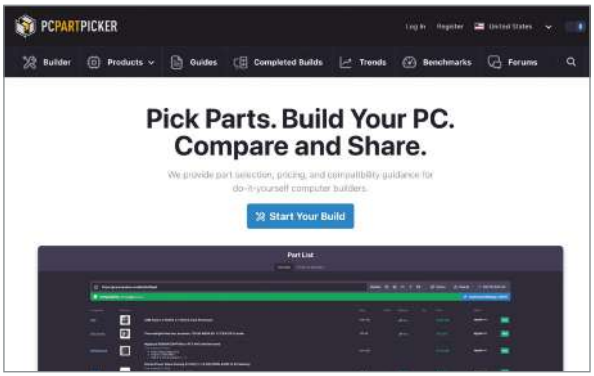
So how should you split your budget? "There are no rules of thumb that fit every user's scenario," said Ben, "but it's a generally accepted truism that 40-50% of your total PC budget should go on the GPU for a premium gaming system. It's the most expensive component and has the largest impact on the frame rate you'll experience. The art is in balancing the remainder of the budget to rule out any bottlenecks caused by poor combinations of the motherboard, CPU, case and cooling components."

We'll come back to how to balance the rest of your budget in a moment.

BEYOND GAMING

While gaming is clearly a big focus for many buyers, it isn't the only one. When Lee talks to customers who want him to help specify and build a computer, he starts with the basics: "What are they going to use it for? What do they use their current machine for? What software packages are key?

"You get your generalists who just want an everyday machine, and then you get the people that say, 'Oh, I use it for this', whether that's AutoCAD, Lightroom, whatever. If it's a gamer, I find out which games they love to play. You need a hook to start with, because very often people come to me because they don't understand whether it's an AMD or an Intel, and they don't care."



ABOVE Sites such as PCPartPicker assume you already know roughly what you want

"Use case of the PC is the most important," said CyberPowerPC's Dave Gornall, "as it allows us to make informed decisions on component selection, and an idea of what the user wants to achieve. However, budget is also important as it allows us to develop an expectation of how the system will operate given requirements."

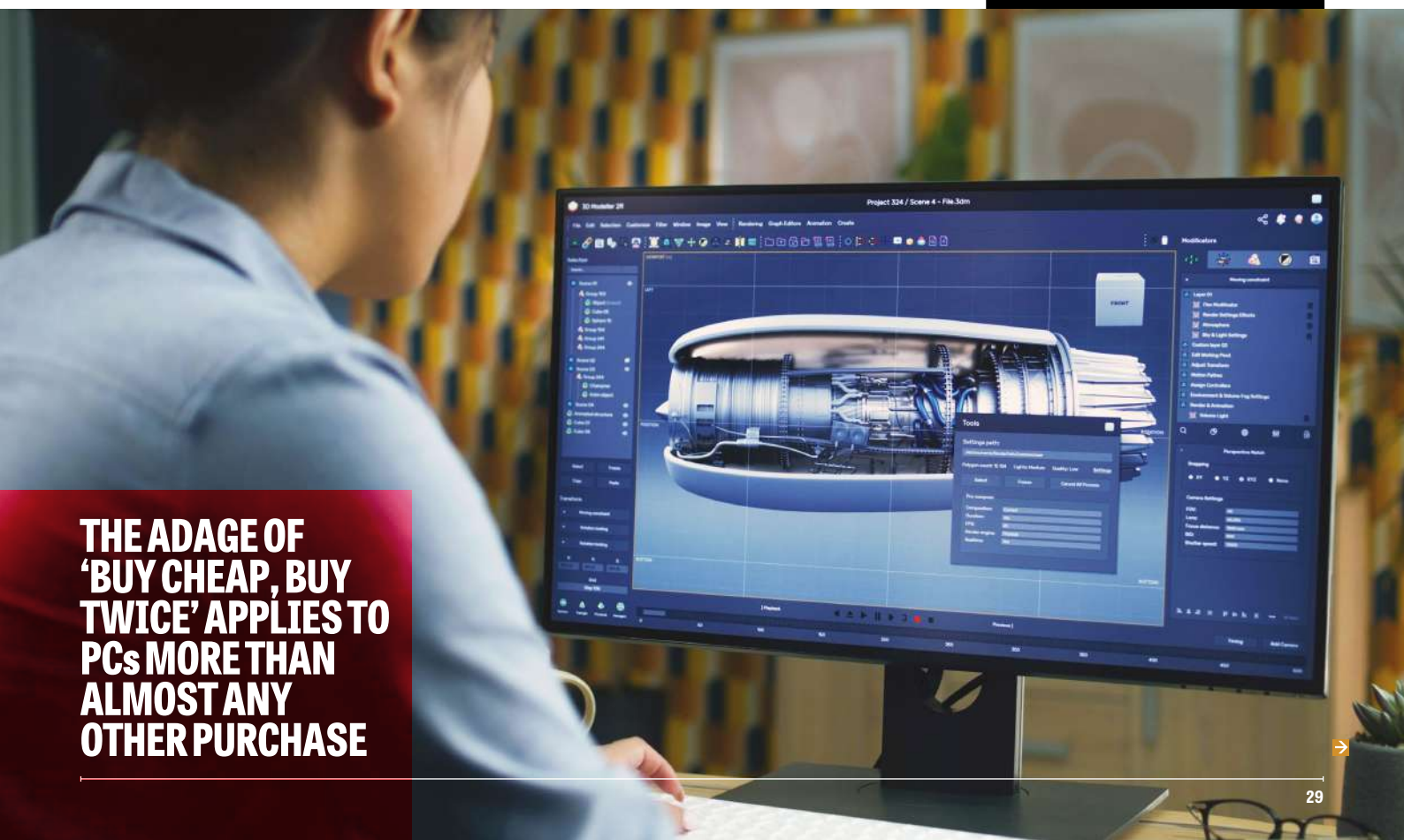
While budget is important, don't tie yourself down too exactly: you should have a ballpark figure, which you then use (either with the help of websites such as PCPartPicker or using the experts on-hand at PC manufacturers) to determine what level of processor, motherboard and graphics card you can afford. After that cornerstone is in place, everything else should follow.

But there's one more thing to consider: your budget may be too low. "The adage of 'buy cheap, buy twice' applies to PCs more than

DON'T WASTE CASH!

If you find you simply can't build the right PC for your budget, how do you make sure you trim in the right places? "Performance first, aesthetics later," said CyberPowerPC's Dave Gornall when we asked him this question. "There are many different ARGB, LCD and OLED options out there, from cases to fans to coolers and even motherboards, but these usually come with a premium price. Make sure the core components of the PC meet expectations first, before spending a ton of money on cosmetic upgrades. These can usually be upgraded down the line, but having a strong, well-performing PC is the most important thing."

Wired2Fire's Ben Miles points out that some customers decide to save money on the monitor and peripherals, which in his view is the most foolish decision of all. "There's no point in having an RTX 5090-based PC plugged into a 1080p or even 1440p monitor, yet we see this time and again," he said. "Likewise, a premium setup demands a premium keyboard, mouse, monitor and headset. Not Amazon specials. Within the build itself we often see bargain-bin system builders coupling five-year old processors with modern GPUs... this creates dreadful bottlenecks and poor performance, not to mention limited upgrade potential."



BELOW Tailor your components to the tasks you'll be doing every day

THE ADAGE OF 'BUY CHEAP, BUY TWICE' APPLIES TO PCs MORE THAN ALMOST ANY OTHER PURCHASE

IN THE 'MONEY NO OBJECT' CATEGORY, AMD X3D PROCESSORS HAVE A CLEAR ADVANTAGE OVER INTEL

almost any other purchase, but careful component choices can yield surprisingly good performance in most applications from modest budgets," said Ben. "The key is to set realistic expectations; £1,000 won't get you a Triple-A 4K gaming monster, but it will certainly allow you to enjoy all current releases at more modest settings that still blow away console alternatives."

AMD vs INTEL

Next we asked about the ongoing battle between AMD and Intel on the processor front, and AMD versus Nvidia for graphics cards. What would you recommend at the moment?

"In the 'money no object' category, AMD X3D processors have a clear advantage over Intel alternatives for gamers, and anyone spending upwards of £2,000 should really accept no substitute," said Ben.

"In the HEDT [high-end desktop] space, AMD Threadripper has ruled supreme for many years now with barely any competition." If you need any evidence of this, simply turn to our group test of content-creation workstations from p76.

ABOVE The AM4 platform has given users confidence that AMD will support a standard for years to come

Away from the high end, things are more balanced. "Intel and AMD trade blows for the best performance per pound spent," said Ben. "What steers us towards an unequivocal AMD recommendation is its long-term commitment to supporting socket platforms, and processors that don't have a recent history of suddenly dying. We used to say 'there's no such thing as a bad processor, only a bad price', but the 13900K and 14900K debacle proved that to be untrue."

Ben is referring to a bug that caused instability and crashes – in some cases, meaning the processors were actually damaged – until Intel issued microcode updates in August and September last year. "A lot of gamers have been turned away from Intel because of that," said Lee.

Historically, AMD also provided better value overall thanks to the cost of its package: not only the CPU, but the motherboard and memory. This advantage isn't as clear cut since both Intel and AMD switched to DDR5 memory, however, and away from high-end gaming machines Lee doesn't believe that either brand holds a big advantage.

On the morning we chat, Lee has two Intel-based machines sitting ready to be built behind him, but he says this is unusual. "I think the graphic performance of the Radeon graphics in AMD's desktop chips far outstrips Intel's, so I tend to go with AMD. The other thing that has been historically very good is the power of the AM4 chipset. I've got another machine here which is AMD AM4, and there's a load of parts coming today to modernise that." While AMD has established a great reputation for supporting its chipsets long-term, the same can't be said for Intel, which has chopped and changed in recent years.

AMD vs NVIDIA

"The video card question is by no means as clear-cut as it was a few months ago," said Wired2Fire's Ben Miles. "The market has been very lukewarm towards Nvidia for the 50-series launch, with most media outlets accusing Team Green of very

AMD AM5 CHIPSETS COMPARED

CHIPSET	TYPE OF BUYER	PCIe 5.0 GRAPHICS?	PCIe 5.0 SSD?	TOTAL PCIe LANES	TOTAL PCIe 5.0 LANES	CPU OVERCLOCK?	DDR5 OVERCLOCK?	USB 3.2 GEN 2 (MAX)	USB 3.2 GEN 2X2 (MAX)	USB4	SATA PORTS (MAX)
X870E	Enthusiast+	✓	✓	44	24	✓	✓	12	2	✓	8
X870	Enthusiast	✓	✓	36	24	✓	✓	6	1	✓	4
B850	Mainstream+	✗	✓	36	4	✓	✓	6	1	Optional	4
B840	Mainstream	✗	✗	34	0	✗	✓	2	0	Optional	4
X670E	Enthusiast+	✓	✓	44	24	✓	✓	12	2	Optional	8
X670	Enthusiast	✗	✓	44	8	✓	✓	12	2	Optional	8
B650E	Mainstream+	✓	✓	36	24	✓	✓	6	1	Optional	4
B650	Mainstream	✗	✗	36	0	✓	✓	6	1	Optional	4
A620 / A620A	Budget	✗	✗	32	0	✗	✓	2	0	Optional	4

Please note that motherboards will have their own limitations so check before buying

lacklustre generational performance uplift and an overreliance on frame-generation technologies. AMD, by contrast, has seen a hugely positive response to its 9000-series releases thus far, with considerably better ray-tracing performance and value than previous generations."

AMD is essentially reaping rewards for its focus on low to mid-end GPUs, seemingly happy (for the moment, at least) to leave the high end to Nvidia. If you want 4K gaming at top settings, then your choice boils down to the RTX 5080 and 5090, which "reign uncontested" said Ben. "Outside of that race, there is a very real AMD threat to Nvidia's dominant market position."

ABOVE AMD's RX 9000 cards have earned praise for their value

BELOW Before you spend hundreds on a motherboard, read its manual to understand what it can and can't do

CHOOSING THE RIGHT MOTHERBOARD

One area where it's incredibly easy to become unstuck is the motherboard. The manufacturers don't help by producing such a staggering number of options, so you need to find a way to produce a shortlist that matches your needs.

First, that means choosing the right chipset. Let's assume for a moment that you're going down the AMD AM5 route. That means you have nine chipsets to choose from, as detailed in the table opposite. Ultimately, you need to do your own research to find out what the differences mean. Unfortunately, PCPartPicker doesn't allow you to filter by chipset, but the Wi-Fi option provides a great proxy (assuming you want built-in Wi-Fi). For example, choosing Wi-Fi 7 means you'll mostly see high-end X870E, X870 and B850 options.

Thinking about your storage demands also helps. As you go up AMD's range, you'll see more support for more PCIe lanes (*see our guide to PCI Express in issue 367, p40*). A graphics card grabs 16 immediately, while an SSD typically needs four. So the more storage you add (including via SATA connectors), the more lanes you require.

"Firms have never been very good at explaining exactly what happens if I plug in, let's say, four SATA drives – does that knock out one of the M.2 slots?" said Lee. "You only discover that sort of stuff by reading the manual. You

HOW SCAN IS INSPIRING FAMILIES TO BUILD PCs TOGETHER

Last year Scan Computers launched a "Build With Us" experience that allowed customers who ordered Scan 3XS custom PCs to visit its Bolton base and take an active part in building their computer. The less confident buyer can simply watch and chat along as their expert host assembles the PC, or they can dig in and help – or even build the whole system. The service costs an extra £50, which Scan gives to the expert.

"We started it because everyone I work with here started their careers through building and tinkering with their own systems," said Philip Payseno, director of 3XS at Scan. "And we thought, what an amazing service it would be if someone could come in and build their own computer somewhere that's safe, where you've got all the equipment and there's the right team-mate on hand if you've got any issues."

There's no time pressure, as the build happens in a dedicated room and there's only one customer per day. Scan will even keep you going with cups of coffee during the day. "The nicest thing for us was to see this new generation that potentially have come through consoles looking to buy their first ever gaming PC," said Philip. "We've typically seen that it's the father's hobby, then that's been passed down to the next generation. The father's super excited, because he's there with his son or daughter. And they're really excited about building a new PC."

If you're interested, select the "3XS Build With Us" option at the same time as you place your order.

ABOVE Scan provides everying you need in its "Build With Us" experience

have to research. I spend a lot of time reading manuals, particularly if I'm building something difficult."

Memory choices are much simpler. Both AMD and Intel have shifted to DDR5 RAM, and your choice of motherboard dictates the speed of memory supported and how many RAM slots there are. RAM is almost always sold in pairs as you need two to take advantage of the dual memory channels supported by mainstream desktop processors and chipsets.

How much memory you need depends on usage, but these days it makes little sense to choose less than 16GB in total. If you intend to stream while you game, however, then 32GB is a wise aim.

CHASSIS AND THE POWER SUPPLY

Choosing a chassis is a hugely subjective decision, so I won't attempt to pre-empt your preferences. What I will say is that there's no point in buying the flashy, RGB-heavy designs if your PC is going to sit out of sight. Which may sound obvious, but it happens. "People get these glass fish tanks now, but the machine's sitting in the corner on the floor in the corner where no-one's ever going to see it, and it's got dayglo lights on it that have cost a fortune," said an exasperated-sounding Lee.

You should also make sure you choose the Goldilocks size of case. I've reviewed PCs with huge, space-consuming cases but a microATX motherboard that barely takes up a third of the available space. Go too small and it becomes a nightmare to replace components or add more memory or storage. Again, sadly, you'll have to do your research – which doesn't necessarily mean watching YouTube videos. "People look at YouTube influencers, not realising the influencer has probably been sent that machine by Cooler Master or whoever, and they haven't built it at all," said Lee.

ABOVE The Lian Li V200 chassis looks stunning – so don't shove it in a corner

WHEN IT COMES TO POWER SUPPLIES, DON'T FALL INTO THE TRAP OF THINKING BIGGER IS ALWAYS BETTER

Fortunately, reputable chassis makers provide all the information you need on their websites, including how many 2.5in and 3.5in disks can be accommodated, and where they go (I like them to hide out of sight behind the right-hand panel), plus the type of cooling systems that are supported.

When it comes to power supplies, don't fall into the trap of thinking bigger is always better. "Over-specifying power supply units is a common mistake," said Lee. "I've seen PCs with an Intel Core i3 and a 1,200W PSU. People think, the more wattage, the quicker the machine: I need to upgrade my power supply for it to be faster, right?" Obviously as a reader of *PC Pro* we wouldn't expect you to fall into that trap, but it's one of the areas where PCPartPicker is a

SELF-BUILD MISTAKES

We asked our experts what common mistakes people make when building a PC. "Buying incompatible components is very easy, as you often need to think beyond simply 'what chip goes in what board'," said Ben Miles of Wired2Fire. "Many combinations of parts don't work when used in unison – for example a video card and a cooler might both be compatible with a particular case in isolation, but not when used together. This is where experience and up-to-date component knowledge is key.

"In the build itself, the most common error we see is novices screwing the motherboard directly into the case without installing standoffs first, and forgetting to remove the plastic protective sheet from the base of a CPU cooler," Ben added. "And of course, TOO MUCH PASTE!!!" This refers to the common mistake of first-time PC makers who plaster too much thermal paste onto the processor (although others add too little).

Lee Grant pointed to "people missing out the value in desktop PCs, which is the upgradability potential. People don't think long term. I've got cases out there that I've been working on for 20 years. The insides are all different. It's like Theseus' ship: who knows if it's still the same machine? If you buy a nice case – and I'm a big fan of Be Quiet! – that thing can last and last and last. And you can just rip things out, shove things in."

People also need to beware of assumptions, such as that wireless is built in. "That surprises a lot of people, when it's not included," said Lee. "And if you're one of those people who keeps your machine on the floor, make sure you get a wireless card that's got external antennas connecting over wire rather than an integrated receiver, because that will be a big help."

ABOVE Follow the manufacturer's guidance when applying thermal paste as it's easy to add too much

CUSTOMERS BUY WATER COOLERS OR LIQUID COOLERS, NOT REALISING THERE IS A LONGEVITY WITH THOSE THINGS

great aid as it will show PSUs with the minimum power options. You may want to add 100W to give your system room to grow, however.

STAYING COOL AND FAN NOISE

How do you ensure that a PC isn't too noisy? "Careful component choice comes first – you need to make sure your cooling hardware isn't going to be overwhelmed by the rest of the parts, as this will invariably result in fans running at full tilt to compensate," said Wired2Fire's Ben Miles. "Choosing sensibly RPM-limited fans also means the PC won't be too loud, even if they do run at full speed. Don't underestimate the importance of sympathetic vibrations and resonance – it's easy to undo good cooler choices with a mechanical hard drive or rattly fan screwed directly to the metal chassis."

As CyberPowerPC's Dave Gornall points out, though, noise is a subjective issue. "[It] depends on the use-case scenario; however, only using high-quality fans that have PWM control is pivotal as it allows the end user to have full customisation of the fan volume. Having a less aggressive fan curve can reduce the audio output without any detriment to performance."

It may surprise some readers that often the quietest PCs we review in *PC Pro* are the ones with the highest number of fans. Much of that is due to the skill and knowledge of the builders, who understand exactly how the air flows in the chassis. Nor should you imagine that a liquid-cooled PC is always quieter than an air-cooled one: the main purpose of liquid cooling is to provide more efficient cooling by using liquid to suck heat away, and then cool the liquid using a separate batch of fans. In fact, liquid coolers normally add to the number of fans in a system.

ABOVE Liquid-cooled PCs aren't necessarily quieter than air-cooled ones

Anyone building such a system should tread carefully, heeding the words of PC repairer Lee. "Customers buy water coolers or liquid coolers, not realising there is a longevity with those things," he said. "And you need to keep an eye on them, because they do leak and they do destroy systems' power supply units."

Our final word on the physical side of building a PC is about the related subject of cable management. How important is good cabling? "It sets apart a professional build from an amateur build," said Ben. "All PCs built by a manufacturer willing to ship and warranty a PC should have impeccable cable management. Good cable management isn't just about aesthetics – it can transform thermals as well. A key skill when building a PC is to balance airflow in and out of the case, and ensure air is moving in logical directions over key hot spots."

BELOW Good cable management sets a professional build apart from an amateur one

GIVE IT A GO!

If there's one lesson to learn from our experts, it's that building a great PC isn't easy. But that doesn't mean you shouldn't try it yourself. "Give it a go, but do your research first and don't expect it to be 100% plain sailing," said Wired2Fire's Ben Miles. "If it doesn't power on first go, stay calm, don't panic and seek advice."

My one word of warning is that you shouldn't necessarily expect to save a lot of money. You can save a small amount, but your PC won't include the warranty or the reassurance of an expert at the end of a phone line if strange noises start appearing after six months. Also be aware that, unless you go down the Linux route, you'll have to pay for a Windows licence. Rather than paying Microsoft an extortionate fee or risking a dodgy licence, I recommend you head to the *PC Pro* store (**store.pcpro.co.uk**) where you can pick up Windows 11 Home for £60 inc VAT and Windows 11 Pro for £10 more.

Like Ben, Lee encourages people to try building systems themselves. "Our business is called Inspiration Computers, with our idea – 20 years ago – that we would inspire people to do more with their computer. That includes building them," he said.

"It's about just encouraging people to have a go, because that promotes sustainability, because it encourages things people to think, 'I can fix this, I don't have to go out and buy a new PC'. You know, it's not a big, scary thing: PCs are a lot easier to build than they used to be. It's only when it becomes more complicated with LED lights, water coolers and multiple fans that it becomes challenging. Yet these very basic machines sitting behind me will be running in 15 minutes, because it's absolutely child's play. So I encourage everyone to have a go."

There are many more myths around Colossus than there are accurate stories. Tim Danton unravels the mystery with the help of a professor, engineers and historical records

COLOSSUS

THE TRUE STORY

On 1 September 1939, Post Office engineer Tommy Flowers found himself in Berlin to take part in a European conference about telephone systems. Germany invaded Poland the same day.

Flowers and a fellow British delegate went to the British embassy to let them know where they were staying. "The young man at the embassy... looked at us and said, 'You people must be mad, there's going to be a war in a few days'," Flowers said in 1998. "Which surprised us a bit."

The British duo spent the next day with their German counterparts on the committee, trying to play it cool, but the next morning the embassy called to say they had to catch the next train out or else. A tense eight-hour journey through Germany followed, but the men were back in London by 8am on 3 September.

It had been a lucky escape for both men. Many British citizens unfortunate enough to be in Germany on the day Britain declared war were detained at internment camps until VE Day in May 1945. It was an even luckier escape for the British war effort, because without Tommy Flowers there would have been no Colossus – and without Colossus, the Allies' path to Germany would have cost many more lives, on both sides.

Flowers and valves

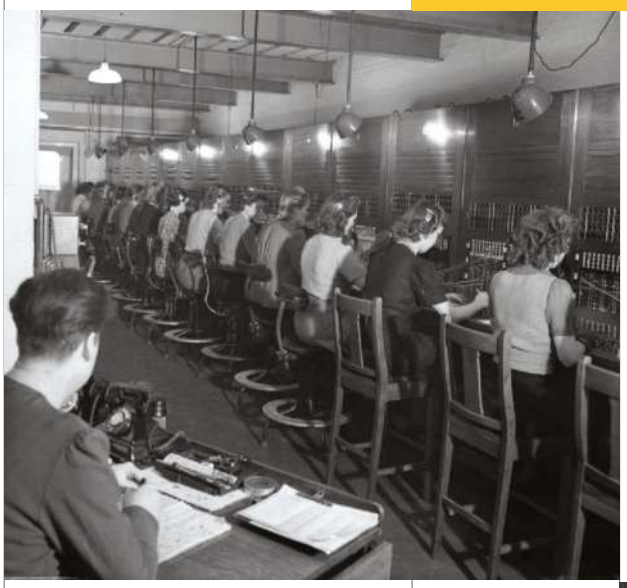
To understand why Tommy Flowers was so intrinsic to Colossus, we need to go back to 1926, at which point Flowers was still only 20, when the General Post Office (GPO) decided to accelerate its move to automatic telephone exchanges. Desperate to modernise, the GPO needed engineers and they needed them fast. So they invited school leavers to take an examination, with the best performers invited to join the scheme. And Tommy Flowers, it turns out, was the best of the lot, beating hundreds of others to top the exam scores.

Within three months of starting, Flowers said he was "yanked out of" general training and sent to the GPO's Circuit Laboratory. It was Flowers' job – along with everyone else in the lab – to design new circuits based on electromagnetic relays that could be rolled out in exchanges. Much of his work was akin to programming today, but rather than coding in software, Flowers was coding in hardware. First it was a matter of designing the circuits, then testing them to see if they worked as desired.

The Post Office installed London's first automatic exchange in Holborn in 1927, and by the time Flowers left the Circuit Laboratory in 1930 "we were well advanced, we got a lot of exchanges working, and they were working reasonably well." He left to join the Post Office Research Station in Dollis Hill, where he was assigned to work with a senior engineer who was studying the problem of long-distance dialling.

"With ordinary electricity in wires, the limit to the distance is about 40 miles," said Flowers. Voices would become too faint to hear. "This chap I was put with was saddled with the problem [but] wasn't getting anywhere because he wasn't any good... but after about six months, during which time I almost went barmy, he was then promoted. If you had someone on your staff who wasn't any good, the only way to get rid of him was to get him promoted."

Without Colossus, the Allies' path to Germany would have cost many more lives



When Flowers was given the job to solve, he turned to thermionic valves. He realised that not only could these replace electromechanical switches, and work thousands of times faster, they could also be used to amplify people's voices. By the outbreak of war in 1939, his valve-based system had moved out of the lab and into production. The Research Station also had a new boss in the form of Gordon Radley, who Flowers described as a "warped genius". Radley had an astounding memory for detail and he needed it, as the Dollis Hill team stopped all civil tasks and focused instead on the war effort.

Flowers spent the early part of the war working out the best way to transmit data from radar stations on the coast to Fighter Command in Stanmore, London. It wasn't until early 1942 that he signed the Official Secrets Act and was informed of the code-breaking work being done at Bletchley Park. From that point on, revealing anything about his work with the Government Code and Cypher School (GC&CS) would be treason.

The listening game

We should briefly pause to mention a side of Britain's code-breaking weaponry that rarely gets a mention: the radio listening stations, called Y stations, that intercepted enemy communications. "They were kind of the front wall, they were picking up the messages, and if it hadn't been for them, there would have been nothing for the code breakers to break," says Jack Copeland, professor of logic at the University of Canterbury in New Zealand, and a world authority on the Colossus.

One visit to a Y station concerned a different code-breaking challenge: a new type of signal had been picked up by one of the stations in the latter half of 1940, with more following in early 1941. Quite unlike Enigma, which transmitted in Morse code, messages of this new type were sent as teleprinter code. Here, each character is represented by a five-strong pattern of pulses and non-pulses. Y, for instance, is pulse-gap-pulse-gap-pulse. Or 10101 in binary notation.

ABOVE GPO staff in the telephone exchange at the Ministry of Information in 1941

LEFT INSERT Colossus wouldn't have been built without the genius of Tommy Flowers

RIGHT A new type of encrypted message was received by teleprinter in 1940

Initially, the existence of these pulses was merely noted. There was too much else to do. It was only in June 1941, when an RAF station near Folkestone intercepted an unencrypted message revealing military details, that Britain's network of intercept stations began

to record them. Naturally, these messages – now encrypted with an unfamiliar cipher – were sent to Bletchley Park for examination.

By the end of August 1941, Bletchley Park knew several things about these non-Morse broadcasts. Crucially, they knew they were encrypted using the Vernam cipher, which added a "random" value to each of the five dots or crosses (called impulses) that made up a character in the teleprinter code. So, if you were to encrypt Y (10101) with the encrypting key of J (11010), then the new enciphered character would be the sum of its parts. Adding the first impulses together means adding 1 to 1, giving the "answer" 0 (note there is no carryover to worry about here, which is why 1 plus 1 is 0). For the second component, we're adding 0 to 1, so the answer is 1. Going through all five components, Y + J is 01111, otherwise known as the pulses • x x x x . That is, the letter T.

One more crucial thing to understand about the Vernam cipher the Nazis were using is that you decrypt by applying the same key. So, adding T (01111) to the encrypting key J (11010) gives you the original character Y (10101).

Bletchley geniuses

To understand Colossus, we don't need to go into all the work done to break this new code, referred to as Tunny. But break it the great minds at Bletchley Park did, with the unwitting help of the German military. Believing that their code was unbreakable, they provided the opening settings of the 12 wheels in the "Tunny machines" via the first 12 characters of each message.

Such complacency couldn't last forever. In November 1942, they issued a code book to Tunny operators. Rather than provide the 12 wheel settings, the operators were given a reference number that they looked up in the book to discover the starting positions for the wheels. Suddenly, Bletchley Park was plunged into near-darkness unless two messages were sent with the same indicator (called a depth). This allowed the British code breakers to apply a method devised by Alan Turing – called Turingery – that could extract the wheel settings.

Bletchley Park couldn't wait for depths; too many messages were left encrypted and unread. Fortunately, the brilliant Bill Tutte devised a way to work out the starting positions of the first two wheels by applying statistical methods to Turingery. His so-called "1+2 break" meant that with enough time the code breakers could detect the most likely wheel start positions by counting (and adding) the dots and crosses of each individual letter.

The core idea was to "add" each letter (remember, it could be broken into a series of zeros and ones) in the encrypted message to every possible combination of encrypting key from the first two wheels, then count up the dots. Then slide it along by one and repeat the process. And so on until you had tried all the different possible streams. Tutte worked out that if around 54% of the individual pulses were zeros when totalled up, the wheel settings were almost certainly correct.

But the sharper-eyed reader would have spotted the phrase "enough time" above, which hides a large problem. Enough time could mean centuries for some messages. Even though they only needed to deduce a pair of wheel settings to begin the process, that meant 1,271 (41 x 31) different scans of the text to spot likely candidates. And as this was a statistical method, they needed long messages, not short ones.

All of which meant they needed a much quicker way to count and add – and that meant some form of automatic adding machine. Tutte took his 1+2 break theory to Captain Gerry Morgan and Max Newman, two of the most senior figures at Bletchley Park. In what historian Jack Copeland describes as "a moment of inspiration", Newman realised that one of his University of Cambridge colleagues, Eryl Wynn-Williams, had already designed an electronic counter based on valves that he thought could be adapted for this crucial part of the job. He called in Wynn-Williams to take control of that side of the design, with the GPO in charge of creating the drive mechanism for the tapes, the photoelectric readers to detect dots and crosses as they passed, and a combining unit to add up the numbers.

Two exceptional GPO engineers, Eric Speight and Arnold Lynch, produced the photoelectric readers, but the combining unit – which used electromagnetic relays – proved more challenging. It was time to call in the expert, Tommy Flowers.

"I quickly came to the conclusion that the [machine] would never be any good, that we were wasting time on it," said Flowers. In particular, he was extremely sceptical about keeping two tapes in perfect synchronisation. One run with a long message, he pointed out, could take several hours and that would surely be too much for paper tape to stand. "So I thought up something different."

ABOVE Bill Tutte's contribution is celebrated, as here in Newmarket, but not nearly as much as it should be

RIGHT Thermionic valves didn't have a great reputation for reliability when Flowers suggested them

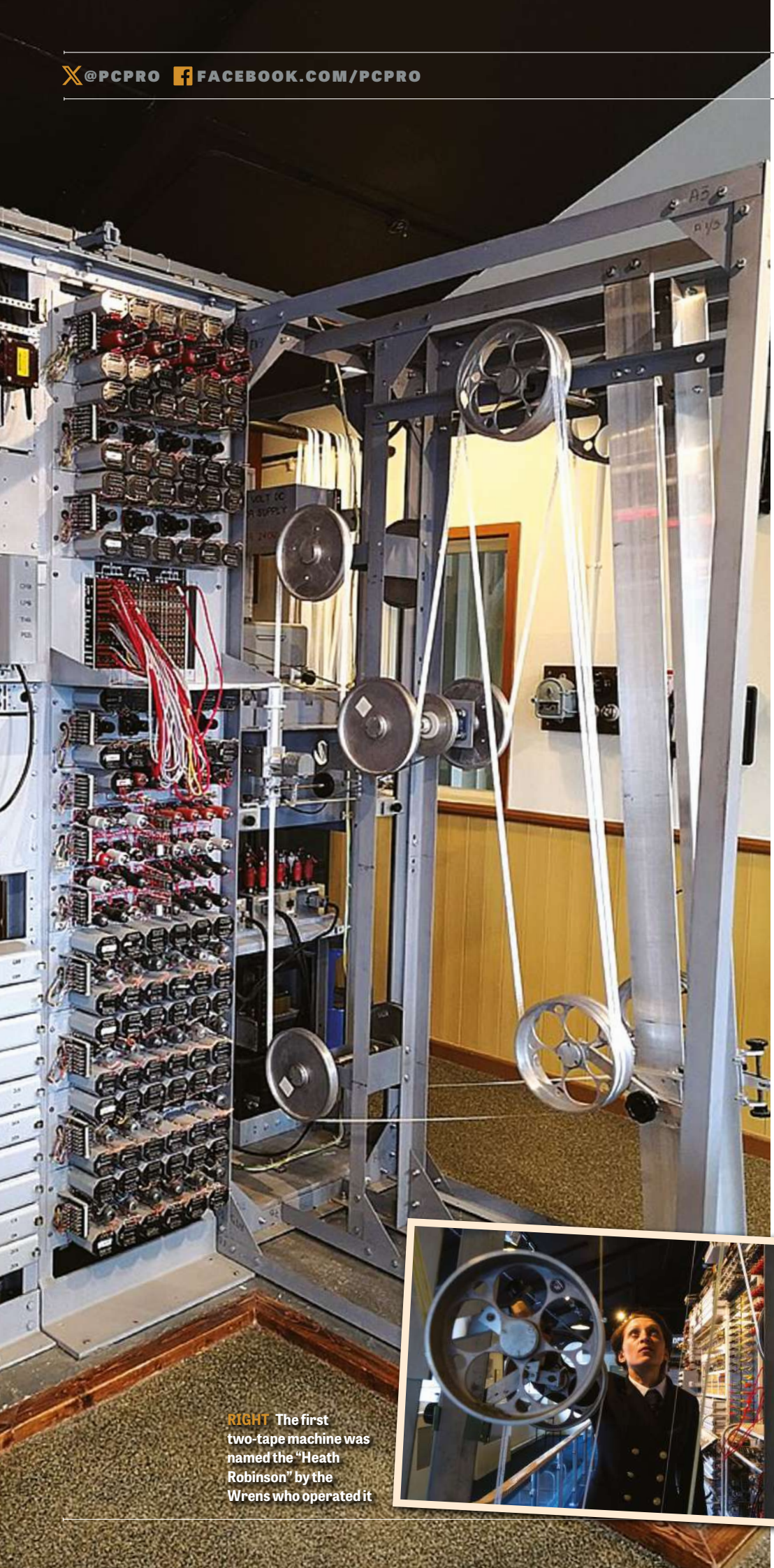
Flowers' key idea was that by using thermionic valves as switches "an analogue of the coding machine could be made". So no need for tape, as the data would be stored within the machine.

While Flowers was convinced his solution would work, he struggled to persuade the Bletchley Park hierarchy. This was partly due to thermionic valves' poor reputation for reliability – used in radio sets and early TVs, they were vulnerable if moved and were well known for their limited operational life – but Flowers had built automatic exchanges with hundreds of valves in them, and knew that they would prove extremely reliable so long as they were kept switched on.

When Newman asked Flowers how long it would take to build, the Post Office engineer gave the honest reply of at least a year. "[Newman] said, well, they just couldn't wait a year; in a year the war could be over and lost," said Flowers.

Rise of the machines

Despite this, Newman cautiously welcomed Flowers' ideas. In a report dated 1 March 1943, he wrote:



RIGHT The first two-tape machine was named the "Heath Robinson" by the Wrens who operated it

"I feel that this is basically the right sort of approach... At the same time, since there is a risk of hold-ups along these new paths, I emphasised that the simpler tape-machine (which also has the advantage of easy adaptability to all sorts of purposes) should be gone on with also, at full speed."

By June, the first two-tape machine – featuring a combining unit that Flowers and his team developed as per the original request – was delivered to Bletchley Park. It was quite something to behold. So much so that it was named the "Heath Robinson" by the Wrens who operated it due to its elaborate, cumbersome design. It worked, but only after weeks of effort by Newmanry section members Jack Good and Donald Michie. Bletchley Park ordered more, and an improved, finessed version arrived in November.

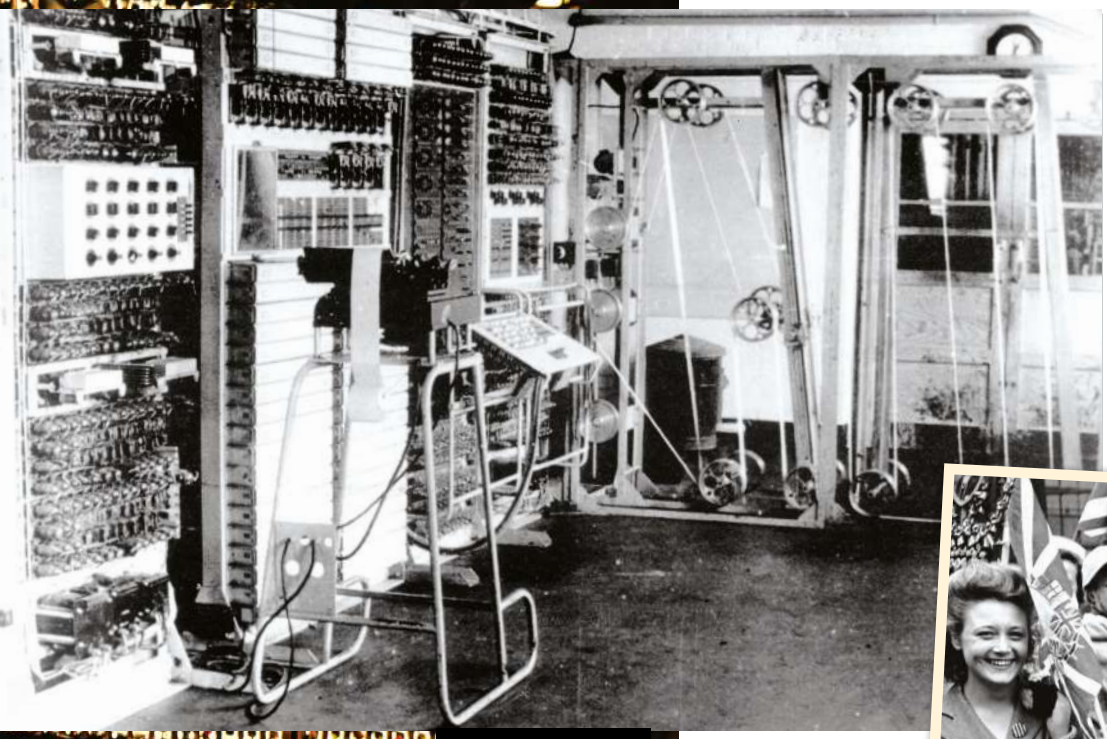
While Bletchley Park wouldn't commit money to Flowers' electronic solution, they told the General Post Office that it could go ahead with the design at its own risk and cost. Fortunately, Flowers had the backing of his boss Gordon Radley, who gave his chief engineer access to all the materials and people he required.

"I knew what it would do," said Flowers. "I drew a lot of square boxes, with lines joining up to these, and I specified what each box had to do." For example, how each box would simulate one of the code wheels. Flowers had to work alone until others could be let into the secret, but was soon joined by talented colleagues.

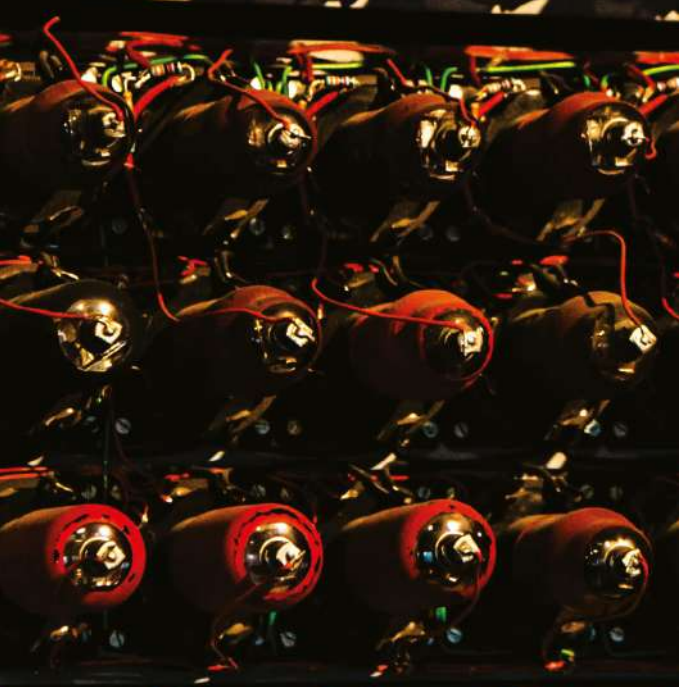
"Sid Broadhurst was a master of system design, and of the logic and timing of complicated relay circuits," wrote Harry Fensom, another member of the team at Dollis Hill, in his article "How Colossus was Built and Operated – One of its Engineers Reveals its Secrets". "Bill Chandler was the expert on digital valve design, and could produce a system that worked straight away when implemented from the drawing board."

In fact, while some histories simplify the computer's story and say that Tommy Flowers "built" the Colossus, he had a large team of engineers working alongside him in the lab, plus the considerable manufacturing power of the GPO to draw upon.

Flowers started designing the first Colossus in February 1943,



ABOVE This shows the circuitry and pulley-wheel system, where the encrypted message was placed



RIGHT Crowds, aside from one unhappy child, celebrating VE Day in Piccadilly on 8 May 1945

Following orders

Flowers and Radley expected Bletchley Park to immediately place orders for more machines, so were surprised when they didn't hear anything. Still, they decided to press ahead with the manufacture of the more time-consuming components so that they would be ready when the call came.

It's a good thing they had a head start, because the following month they were visited by "some man in uniform, straight from the War Cabinet, [who said] that we had to make 12 of these machines by 1 June," remembered Flowers. By then it was obvious to all that it was only a matter of time before the Allies invaded Europe, and their visitor's next statement made Flowers suspect that his machines might just play an important role. "We were told that unless you can make these machines and have them working by 1 June then it would be too late."

with the machine delivered to Bletchley on 18 January 1944 and operational on 5 February. So, a year later, just as Flowers had predicted. It filled a room, more than justifying its name. While the machine was loud – thanks to the use of many electromechanical parts, not the valves – it worked from the get-go.

In his seminal report "The Colossus", computer historian Brian Randell quotes Flowers directly: "They just couldn't believe it when we brought this string and sealing wax sort of thing in and it actually did a job. They were on their beam ends at the time, Robinson just hadn't got enough output, they wouldn't go fast enough, and suddenly this bit of string and sealing wax, in about ten minutes... and then they started to take notice!"

Gordon Radley's wartime diary is more measured in its analysis, but still the delight at its success rings through. "Since February 22nd Colossus has been in full daily operation for 16 hours per day, and, although the operating staff are not yet sufficiently familiar with it to utilise it to the best advantage, it has dealt with eight messages in 11 hours. For the remaining eight hours of its day, Colossus is turned over for the attention of Research Staff who are endeavouring to graft on to it equipment for providing still further facilities."

While the GPO couldn't build a dozen machines in such a short time, Flowers promised that the first new machine would be working by 1 June, with the next two following in July and August. So began an intense four months of effort to build the Colossus II, this time with 2,400 valves. "We worked day and night, six days a week," said Flowers. "We worked ourselves almost to exhaustion."

That work continued right up until the last moment. Only at 1am on the morning of 1 June 1944 did Flowers and his team work out that the reason the Colossus II obstinately refused to work was due to misbehaving valves. This was a problem best left to valve expert William Chandler, so they left him there. "And then Flowers came back the next morning and Colossus II was buzzing away like a top," says Copeland. "Chandler was looking very pleased with himself, but also standing in a pool of water because the radiator had leaked during the night." This, incidentally, is why some reports incorrectly state that

the Colossus was water-cooled; ignore all such articles.

"Between [5am] and 8pm this evening, Colossus II was running continuously and has very successfully dealt with no less than 20 separate tasks," wrote Radley in his diary that day. "This is roughly equivalent to a full 24-hour output from all the other machines at present operated by the Group concerned, and has given very great satisfaction to Professor Newman and Commander Travis."

The Colossus II was so quick thanks to the advent of what can best be described as parallel processing. This involved having the equivalent of five processors working on the same tape, effectively bringing the speed up to 25,000 characters per second. "It meant more gates and counters, of course," wrote Fensom, "but we didn't mind a thousand extra valves."

Nor did Bletchley Park mind throwing hundreds of women at the problem. For while the Colossi revealed the settings for the five chi-wheels, there was still much work to be done before a message could be decrypted, and much of this burden fell to Wrens and women from the army's Auxiliary Territorial Service.

"There were so many messages being sent in, when one didn't come good you were sent another one," Cora Jarman told Tessa Dunlop, author of *The Bletchley Girls*, of her time in the Newmanry. "Checking checking. It was very boring."

After a Colossus had successfully revealed a likely set of starting positions for the chi-wheels, the message needed to be 'de-chi'ed'. This meant processing it through a machine to remove the chi encryption, which one of the women would do. The de-chi'ed message tape would then be taken to the Testery, where the code breakers would set to work. When a complete set of wheel positions arrived, it was women who would set up a Tunny machine and check the output.

So it was hard work for everyone involved, but also vital work. According to legend, on 5 June 1944, General Eisenhower was handed a decrypt fresh from Bletchley Park. He read it, then declared: "We go tomorrow." This may be too neat a story, but it's certainly known that Eisenhower was a regular visitor to Bletchley Park in the run-up to D-Day and an admirer of its work.

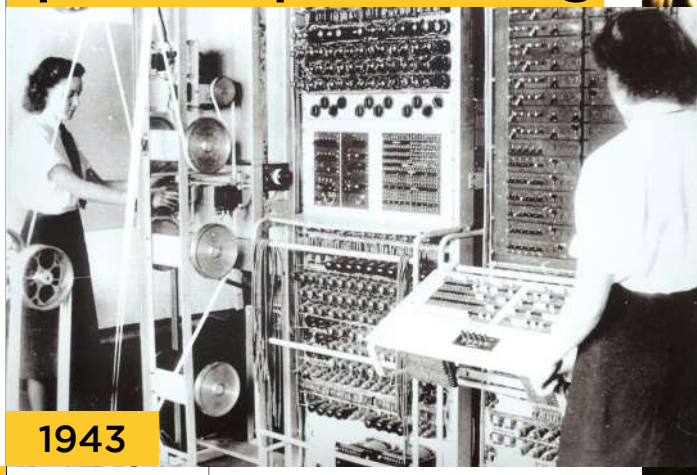
The Colossus effect

We should not oversimplify history to say that the Colossi alone won or shortened the war. Giving all the credit to the computer ignores the months of work done by a network of double agents who had been feeding the Nazis with misinformation. Not to mention other ruses, such as creating fake barracks near Dover, or dropping aluminium foil to create the illusion of incoming planes on German radar. All these deceptions were to convince the German military that the Allies were going to land in Pas-de-Calais rather than their real target of Normandy.

The deception worked. The Nazis held back reinforcements from Normandy, allowing the Allies to establish a strong foothold there. Over the coming months, as the Allies battled their way across Europe, more Colossi were installed. By the end of 1944, seven whirred away, spread across two vast, bomb-proof concrete buildings. Three more Colossi arrived in 1945. "I saw this astonishing machine the size of a room," said Joanna Chorley. "It was ticking away, and the tapes were going round and all the valves, and I thought what an amazing machine... Like magic and science combined!"

What's more, the machines became more magical over time. For example, Bill Tutte created a technique called rectangling that could determine the wheel patterns. However, it required a quite legendary amount of effort by hand, and one tiny mistake could ruin the calculations. Donald Michie, a talented member of the Testery, came up with a proposal that meant a Colossus could become a high-speed rectangling machine through the addition of a "rectangling gadget". A good thing, as the Germans started to change the wheel patterns on a daily basis as they became more concerned about security.

The Colossus II was so quick thanks to what can best be described as parallel processing



1943

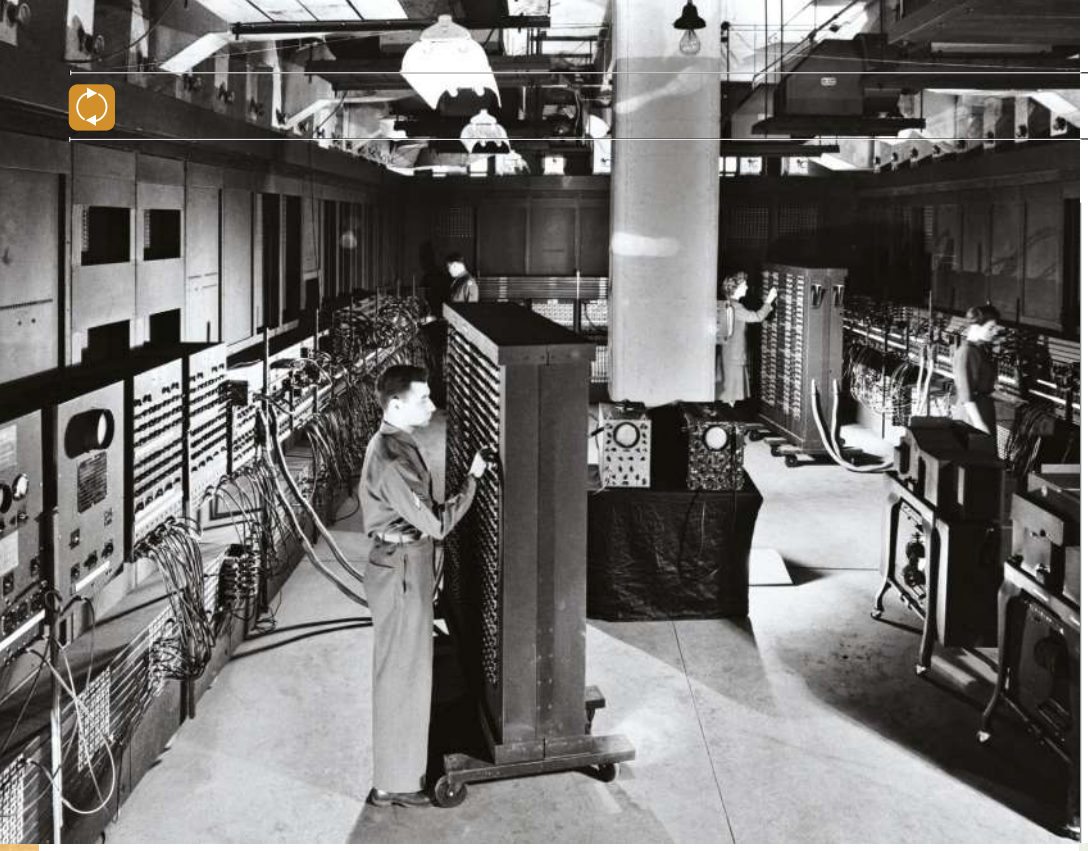
2016

ABOVE Though much of the work was automated, hundreds of Wrens made it all work

LEFT Colossus relied on Wrens such as (left to right) Irene Dixon, Lorna Cockayne, Shirley Wheeldon, Joanna Chorley and Margaret Mortimer

"We were in no doubt about how important [Colossus] was," said Capt Jerry Roberts, a member of the Testery, in 2010. "We saw a number of messages signed by Adolf Hitler himself." The operation became slick, with Roberts adding that "I suspect sometimes we genuinely saw the messages before the blessed Germans".

For the rest of the war in Europe, the Colossi continued to break codes, with the tenth and final operational machine installed in April 1945. A month later, the teleprinters relaying the Tunny messages would fall silent – an eerie experience for those working in the huts – with the final message sent shortly before VE Day on 8 May 1945. This was the date when Nazi Germany unconditionally surrendered to the Allied forces.



Second life

A lack of new messages didn't spell the end for the Colossi. There was still much to be learnt from the backlog of messages still to be deciphered, including clues to the identities of British agents giving material to the Soviet Union. For while the USSR was an ally of sorts, it was always an uneasy relationship.

Moscow must have known about the British success decrypting Tunny, because British civil servant John Cairncross – later unmasked as the fifth member of the infamous Cambridge spy ring that included Kim Philby and Guy Burgess – gave them decrypts that he smuggled out of Bletchley Park by stuffing them down his trousers. But the USSR clearly didn't realise how comprehensively Tunny had been broken, as it grabbed the Nazi cipher machines and used them (with enhancements) to encrypt messages after the war.

However, there was no need to keep all ten active Colossi in service, so the command came to dismantle them. In a 2012 short film to celebrate the 70th anniversary of Colossus's birth, Google interviewed engineers and wirers who worked on the machines. Their most poignant remarks came when describing the Colossi's demise.

"When we had the order to dismantle all the equipment, the idea was to smash everything. Smash all the valves and everything else," remembered Roy Robinson. "Some of [the Colossi] were thrown down coal mines," added Albert Bareham. "The whole piece of equipment was dumped down a disused coal mine and things like that."

Even 70 years later, you can hear the disappointment in the voice of Margaret Bullen (née Boulton), who like other women "with nimbler fingers" helped with wiring and soldering, when she remembers the end of her time at Bletchley Park. "We carried on... until the war was over, and immediately we were told we could go," she said. "You felt cheated in a way that you'd worked so hard on it and that it was going to be no more."

None of them knew at the time that at least two Colossi survived the massacre. These were quietly transported to the new headquarters of GC&CS – renamed Government Communications Headquarters, GCHQ, the following year – in north-west London. The Colossi then moved with GCHQ to Cheltenham in 1951, where they continued to provide valuable code-breaking service for another decade.

"I worked as an engineer on Colossus for a year during the 1960s," wrote Bill Marshall, a former GCHQ engineer, in an article on GCHQ's website to mark Colossus's 80th anniversary. "I was told very little about the machine I was working on – what the machine was actually doing was not for me to know. My job was to repair it as necessary, using just a few circuit diagrams and no detailed user handbook."

The truth unmasked

Despite the computers' retirement in the early 1960s, the government refused to declassify the Colossus project. It was only through the efforts of historians, particularly Brian Randell, that more information came to light in the mid-1970s. It took another quarter of a century for the government to release a 500-page report written by members of the Bletchley Park team, titled "General Report on Tunny", that filled in many of the missing details.

"ENIAC demonstrated very publicly the viability of using large numbers of electronic tubes," said Randell in an interview, "just as Colossus had done on a smaller scale, but privately. Colossus, I think, had an effect within Britain, but a rather limited effect, whereas ENIAC brought 'giant electronic brain' onto front pages."

This doesn't mean the Colossus should be ignored in computing history, as it marked many firsts. The Colossus I was the first computer to use electronic binary circuitry on a large scale. The first to use a clock pulse to synchronise operations. And while it was a special-purpose computer, it and its successors were programmable – to an extent.

Timing naturally becomes important when claiming world firsts, so it should be noted that the first Colossus was operational in February 1944, pre-dating the United States' ENIAC by almost two years. This was why, when Randell – with the assistance of Allen "Doc" Coombs – gave a guarded presentation on the Colossus to the International Research Conference on the History of Computing in Los Alamos in 1976 it caused quite a stir.

Bob Bemer, who helped develop the ASCII character code, wrote a short but vivid article describing the proceedings. "I looked at Mauchly [John Mauchly, co-creator of ENIAC], who had thought up until that moment that he was involved in inventing the world's first electronic computer," he wrote. "I have heard the expression many times about jaws dropping, but I had really never seen it happen before. And [German Professor Konrad] Zuse – with a facial expression that could have been anguish."

All of which begs the question, what might have been different if the Colossi's creators hadn't been sworn to secrecy? Could it have given extra momentum to Britain's efforts? Might it have changed

ABOVE The Colossi pre-dated the USA's ENIAC, but the two computers were very different

RIGHT One of the original Colossus switches, given to the director of the NSA in 1986

computing history? All questions we will never know the answer to.

What we know for certain is that Tommy Flowers, and others involved in the creation of the Colossus, never received the recognition they deserved in their lifetimes. It was only through the effort of Randell that Flowers gained greater recognition in later life. This included an honorary degree from Newcastle University in 1977 and the Charles Babbage award in the late 1990s, but it was only after his death in 1998 that the accolades truly flowed. There is now a blue plaque commemorating the Dollis Hill Research Station, while British Telecom – the organisation that inherited the Post Office's national telephone duties in 1981 – created a statue of Flowers at its research facility in 2013.

Colossus lives on

Colossus itself lives on in two forms. The first is a fully working recreation of Colossus II, created through the hard work of dozens of engineers but the dogged determination of one man: Tony Sale. "In 1991, some colleagues and I started the campaign to save Bletchley Park from demolition by property developers," he wrote. "At the same time I was working at the Science Museum in London restoring some early British computers. I believed it would be possible to rebuild Colossus, but nobody else believed me."

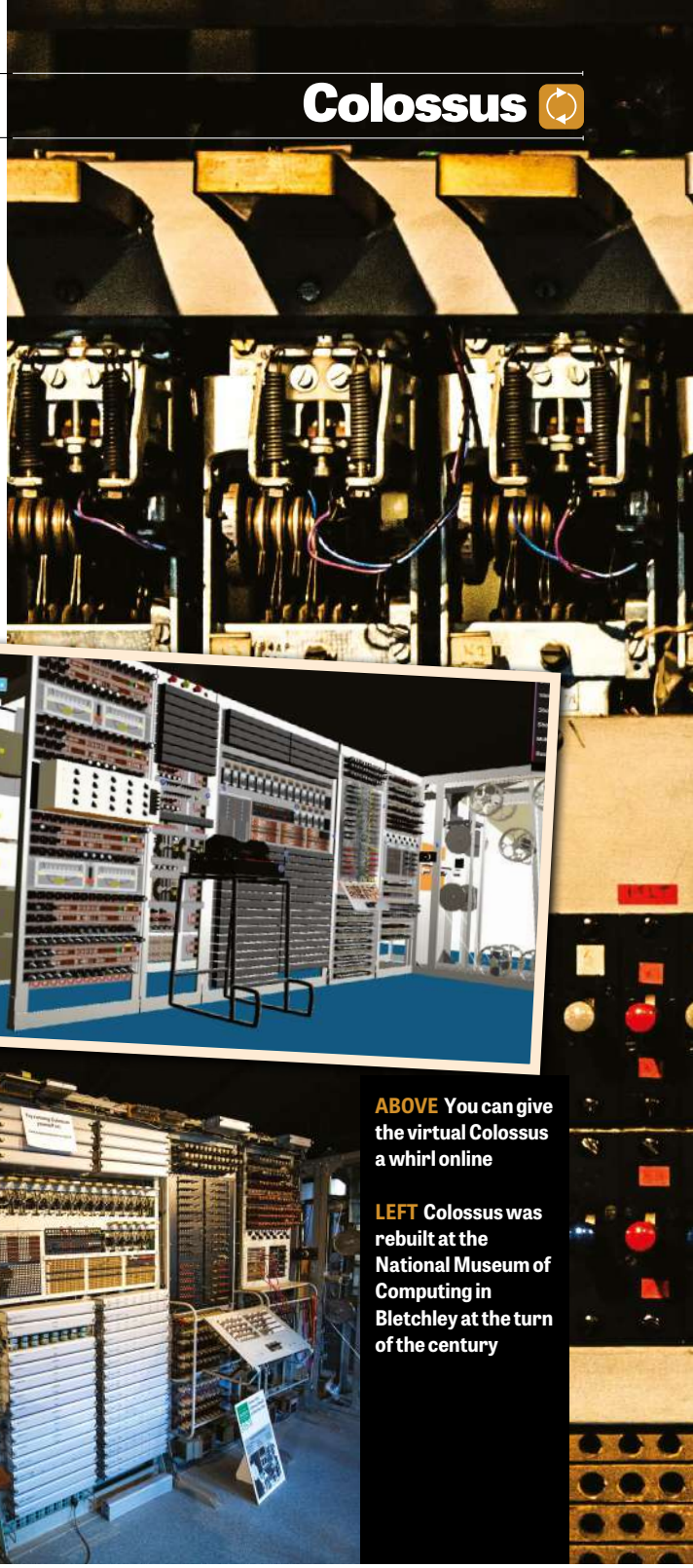
With the help of still-classified documents, circuit diagrams that engineers had illegally kept, and Arnold Lynch, one of the men behind the photoelectric reader, Sale first recreated the design. Then, this time helped by a mix of "current and retired Post Office and radio engineers", they built a limited version of the first Colossus – switching it on in time for the 50th anniversary of the ENIAC in 1996, a ceremony Tommy Flowers attended.

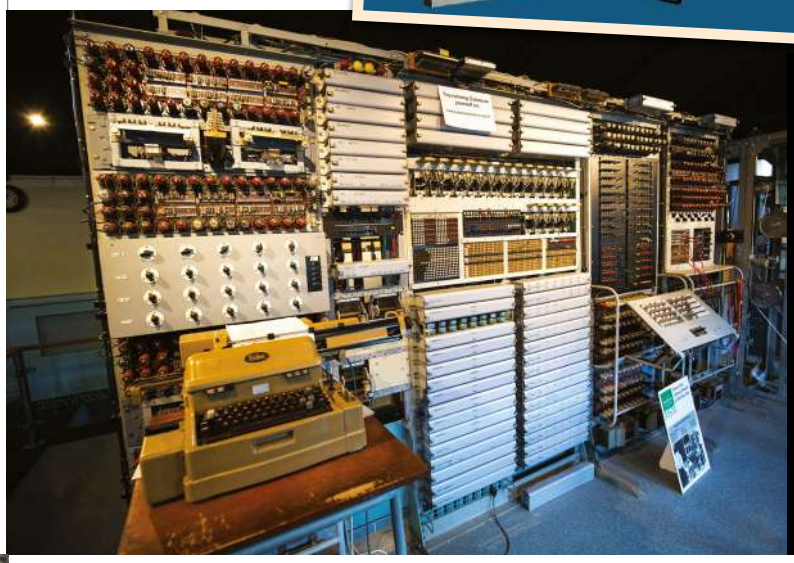
By 2003, after what Sale described as "over 6,000 man-days of effort", the replica of the first Colossus was working almost exactly as designed. But, not content with this, the team decided to "upgrade" to Colossus II. Their self-imposed deadline was 1 June 2004, exactly 60 years after the second computer became operational. This time, there would be no misbehaving valves. "[On] Thursday 20th May I filmed Colossus Mk 2 setting all five K wheels [psi-wheels] on the Bream cipher text and after editing, this video was shown to 120 people at our commemoration event at the Science Museum in London on 1st June 2004," wrote Sale.

The rebuilt Colossus II remains on show at the National Museum of Computing, which is on the same site as Bletchley Park but is run separately. The museum also houses what it claims is the world's largest collection of historic computers and, unlike in most museums, visitors are encouraged to get hands-on with them. The Colossus is very much "look but don't touch", unless you're one of the volunteers who keep it going.

The Colossus is also kept alive by a virtual version – visit **virtualcolossus.co.uk** – where you can see a 3D representation of the computer and even set it to work. While the original program was written by Tony Sale, it was Martin Gillow who recreated it in 3D and brought it up to date.

All of which means that, despite the best efforts of the British government, the very modern legend of Colossus lives on. ●





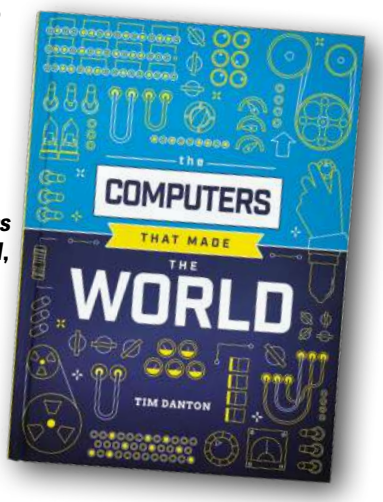
ABOVE You can give the virtual Colossus a whirl online

LEFT Colossus was rebuilt at the National Museum of Computing in Bletchley at the turn of the century

BELOW The Colossus replica is looked after by a team of dedicated volunteers at Bletchley Park

Buy the book!

This article is a shortened version of the full chapter in Tim Danton's new book, *The Computers that Made the World*, published by the Raspberry Pi Press. It's available from Amazon, Waterstones and from Raspberry Pi Press (store.rpipress.cc).



SECRETS OF HOME NETWORK ADMINISTRATION

DARIEN GRAHAM-SMITH EXPLORES THE TIPS AND TOOLS THAT CAN HELP YOU MANAGE YOUR PERSONAL LAN LIKE A PRO

Administration isn't just for corporate IT departments. If you're responsible for the stability and security of any sort of computer network – even a few computers at home – you're an administrator, whether you like it or not. So why not borrow some ideas from the world of professional IT management?

Don't think of it as taking on extra work. Putting a little effort into administration lets you focus the rest of your time and energy on being productive, rather than being distracted by unplanned troubleshooting and housekeeping tasks.

Windows comes with a decent set of built-in, user-friendly management features, including account security, built-in virus protection and automatic updates. But there's plenty more that you can accomplish by digging beneath the surface, and by downloading a few judiciously chosen third-party additions. Here are some of our favourite tips and tools for keeping your network running smoothly and securely.

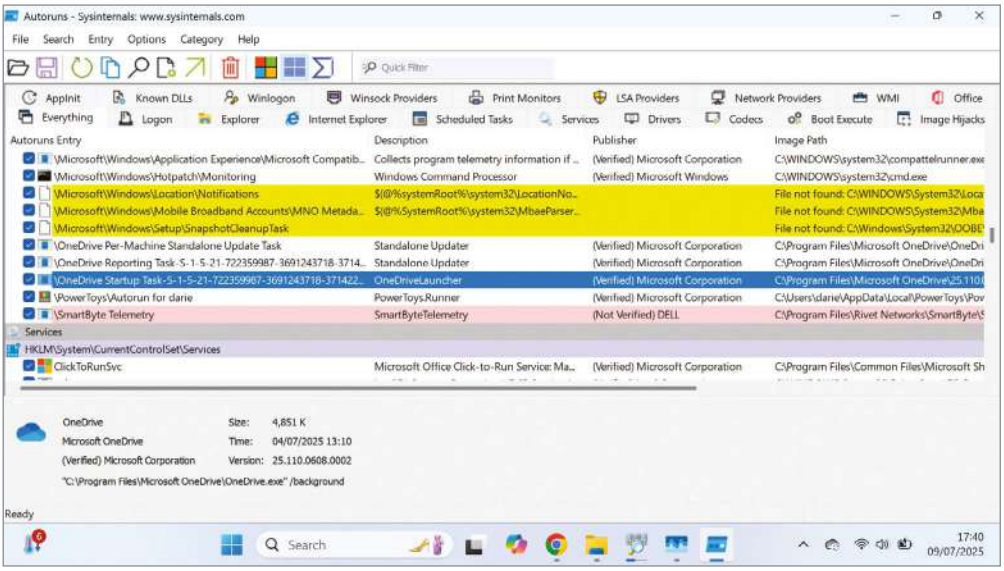
KEEP ONLINE DEVICES SECURE

There's an old saying, "if it ain't broke don't fix it" – and who wants to worry about network devices that seem to be working fine? Unfortunately, when you leave them untouched, the risk grows that they'll become susceptible to newly discovered vulnerabilities.

Things aren't as bad as they used to be. Almost all connected devices in a modern home should be capable of receiving online updates. There's usually even an auto-update option, so that's something you don't need to be continually chasing – but you do need to ensure it's turned on. Indeed, you should check the default settings of all your devices, paying particular attention to any optional privacy and security features.

You can further reduce your exposure to online threats by segmenting your network. Devices such as smart light bulbs, sockets and washing machines can be exploited just like regular computers – in fact, they're often more vulnerable, since the manufacturers don't invest so much time and money into their upkeep. But since they're generally controlled over the internet, they don't need to be able to talk directly to your personal laptop or NAS unit. Cutting them off – putting them on their own subnet with no access to your personal files or shared storage – ensures they can't be exploited as an infection vector for a botnet or ransomware attack on the devices you really do care about.

Some routers offer a dedicated IoT wireless network for just this purpose; others allow you to set up your own VLANs, if you're comfortable with this slightly technical process. Worst case, you can usually activate an isolated guest network and connect your less trusted devices to this rather than the main SSID.



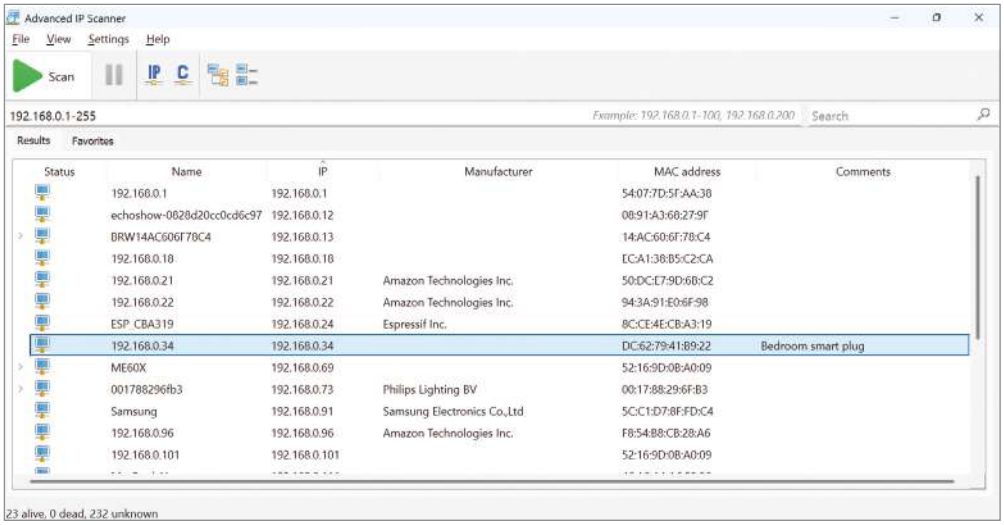
ABOVE You'd be amazed how many processes fire up when Windows boots

AUDIT YOUR NETWORK

To decide what's going to connect to which network, you'll find it helpful to have a complete list of all devices using your router. The router's own management interface can give you a rundown of all attached devices, but this isn't always very helpful; it might well be just a list of IP and MAC addresses, leaving you none the wiser as to what's actually connected.

A free tool called Advanced IP Scanner (**advanced-ip-scanner.com**) can help here. It will scan any range of network addresses (it defaults to whatever subnet your computer is on) and report back with a list detailing not only the names and IP addresses of all discovered devices, but also the manufacturer information, where available.

This can sometimes be the manufacturer of the network card rather than the device itself, but it can still help you identify which device is which – and you can add your own comments to individual MAC addresses for easy future reference. It's perfect for discovering any low-trust devices connected to your primary network, or exposing anything that shouldn't be on the network at all, such as your neighbour's iPhone.


Advanced IP Scanner
File View Settings Help
Scan
192.168.0.1-255
Results Favorites
Status Name IP Manufacturer MAC address Comments
192.168.0.1 192.168.0.1 54:07:7D:5F:AA:38
echoshow-0828d20cc0cd6c97 192.168.0.12 08:91:A3:68:27:9F
BRW14AC606F78C4 192.168.0.13 14:AC:60:6F:78:C4
192.168.0.18 192.168.0.18 EC:A1:38:B5:C2:CA
192.168.0.21 192.168.0.21 Amazon Technologies Inc. 50:DC:E7:9D:6B:C2
192.168.0.22 192.168.0.22 Amazon Technologies Inc. 94:3A:91:E0:6F:98
ESP_CBA319 192.168.0.24 Espressif Inc. 8C:CE:4E:CB:A3:19
192.168.0.34 192.168.0.34 DC:62:79:41:B9:22 Bedroom smart plug
ME60X 192.168.0.69 52:16:9D:0B:A0:09
001788296fb3 192.168.0.73 Philips Lighting BV 00:17:88:29:6F:B3
Samsung 192.168.0.91 Samsung Electronics Co.,Ltd 5C:C1:D7:8F:FD:C4
192.168.0.96 192.168.0.96 Amazon Technologies Inc. F8:54:B8:CB:28:A6
192.168.0.101 192.168.0.101 52:16:9D:0B:A0:09
23 alive, 0 dead, 232 unknown

BELOW A simple network scanning tool can identify everything hiding on your network

TAME YOUR STARTUP ITEMS

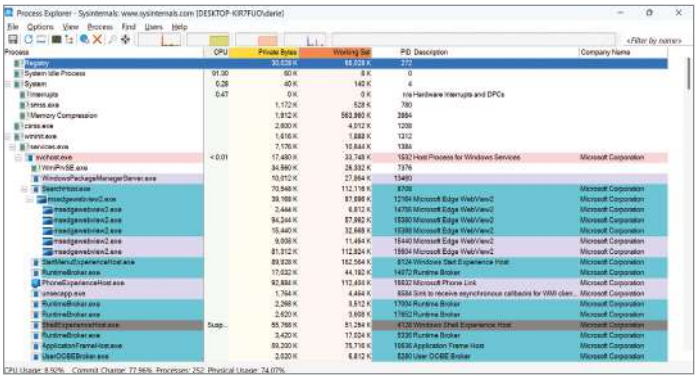
Being a network administrator means taking full ownership of everything that's running on each computer. Unfortunately, Windows systems tend to get clogged up with programs that launch automatically each time you start up the computer. Aside from security concerns, these can slow down the machine or pester you with unwanted interruptions.

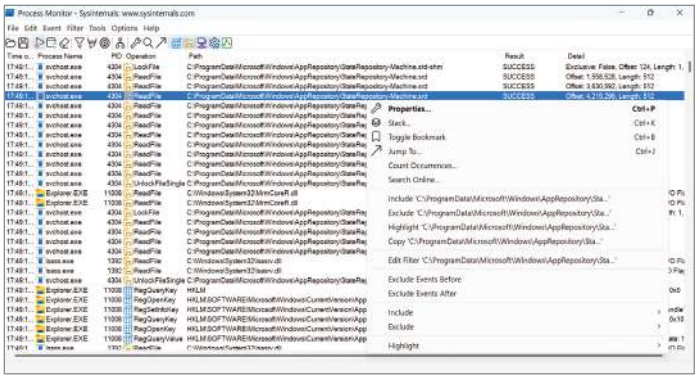
You can view a list of "autorun" programs from the Task Manager. Clicking the fifth icon down in the sidebar (which looks, rather unintuitively, like a speedometer needle) brings up a list of self-starting programs, and provides an easy way to disable anything you don't like the look of.

That's nowhere near the whole story, however. For a more in-depth look, download the free Sysinternals Autoruns program from **tinyurl.com/373autoruns**. This gives you a comprehensive readout of every process that executes when you boot up Windows and log on, including not just conventional startup items but device drivers, printing components, Explorer extensions and more.

Each item is shown with a description if available, and a path to exactly where the file is located on your hard disk. Right-click on any item and you can do all sorts of useful things, including deleting it, jumping to its location on disk, checking it against the VirusTotal malware database and searching for more information about it online.

In truth, the sheer volume of information Autoruns provides can





be overwhelming. For this reason there are 19 filter buttons at the top, which you can click to see only items of certain types.

MANAGE RUNNING PROCESSES

Two other Sysinternals tools can help you keep a more general eye on what's running on a Windows machine. Process Explorer (**tinyurl.com/373procexp**) is like Task Manager with the guardrails removed: it breaks down absolutely everything that's running on your PC right now, with a far greater degree of detail and control than Windows' built-in tool. You can hover your mouse pointer over any item to see details of exactly how it was launched, and from where; a particularly powerful feature is that you can also search for which process is accessing a specific file using the Find | Handle or DLL menu option.

Don't ignore Process Monitor, either (**tinyurl.com/373procmon**). This expert utility doesn't just show you which programs are running, it exposes exactly what files (and Registry keys) they're reading and writing.

When you first run it, the window will instantly fill up with thousands of entries every second, from all the different processes running in a multitasking operating system. Fear not: you can calm the flood using Process Monitor's powerful filtering options. Just right-click on a process name, operation or path and you'll see options to include or exclude matching items from the display.

ABOVE Process Explorer provides a complete overview of everything running on a PC

ABOVE RIGHT Process Monitor records all file-system and Registry activity

Used in combination with the built-in search option, Process Monitor's filters let you quickly zero in on items of interest. You can then see for yourself exactly what a particular executable is doing, or identify which process is meddling with your files. Just note that the tool works in real-time, so it won't be able to tell you about things that happened before you opened it.

ADVENTURES IN SPACE AND BANDWIDTH

Windows can misbehave when disk space gets low, and if you run out of storage entirely that's obviously going to affect your ability to get things done. Two utilities built into Windows can help you manage local drive space: the classic Disk Clean-up tool will find and remove old, unneeded downloads, caches and update files, while Storage Sense (located in the Windows 11 Settings app) can automatically clean up extraneous files when disk space is low, or to a user-selectable schedule.

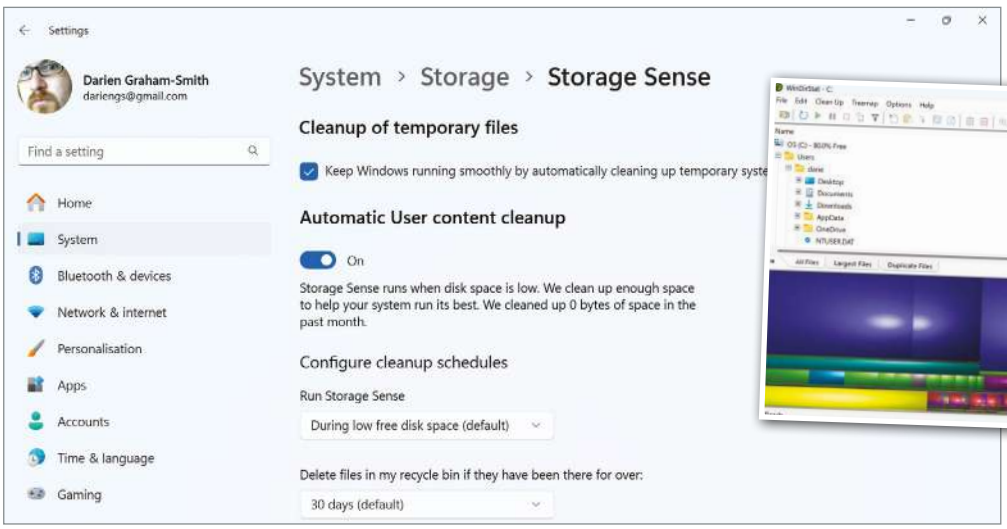
For a more detailed breakdown of exactly what's taking up space, you'll want to turn to third-party tools. The free WinDirStat utility (**windirstat.net**) will scan any drive or volume – including network locations – and present an expandable tree view of all its folders and subdirectories, along with the size of each one on your disk. Below this, a handy graphical visualisation of the layout of your file system lets you instantly spot where the biggest files are hiding.

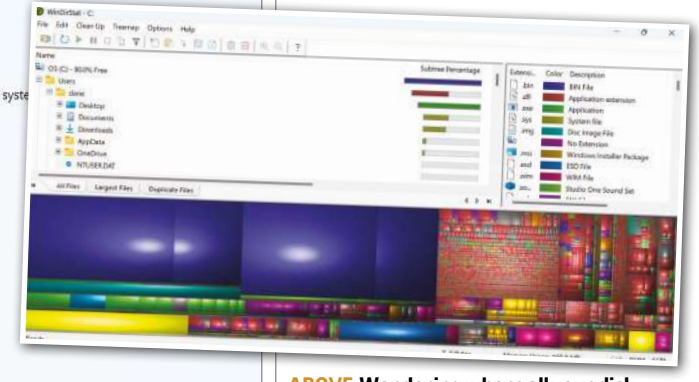
As well as trimming unwanted process and files from individual computers, check whether you can accelerate your network with a little traffic management. Many routers have built-in tools to break down traffic by client, so you can see if one device is eating up all the bandwidth. You can also break down traffic by type, making it easy to spot if your internet connection is being bogged down by games and BitTorrent downloads. Most routers offer more or less sophisticated QoS (quality of service) settings that you can use to prioritise clients and/or types of traffic.

FOLLOW THE SCRIPT

Professionals know that the secret to administration is automation – making sure your essential tasks get done reliably and efficiently by the computer, so you don't have to remember to do them by hand.

For this purpose, the Windows Task Scheduler is an amazingly powerful tool. Open it by simply searching for its name from the Start


Settings
Darien Graham-Smith
dariengs@gmail.com
Find a setting
Home
System
Bluetooth & devices
Network & internet
Personalisation
Apps
Accounts
Time & language
Gaming
System › Storage › Storage Sense
Cleanup of temporary files
Keep Windows running smoothly by automatically cleaning up temporary syste
Automatic User content cleanup
On
Storage Sense runs when disk space is low. We clean up enough space to help your system run its best. We cleaned up 0 bytes of space in the past month.
Configure cleanup schedules
Run Storage Sense
During low free disk space (default)
Delete files in my recycle bin if they have been there for over:
30 days (default)



ABOVE Wondering where all your disk space has gone? WinDirStat exposes the biggest files

BELOW Windows can automatically try to free up hard disk space

menu. You can configure it to run any command or program when a set trigger condition is met, which might be a schedule, a user logging on or some other event.

What makes the Task Scheduler particularly powerful is that it can launch batch files and scripts written in PowerShell, Python or any other language you care to name. This means pretty much any task that you need to do on a regular basis – either for housekeeping purposes or as part of your workflow – can be delegated to run automatically at whatever intervals you desire.

With a little external help, it's even possible to automate tasks that would ordinarily require interactive mouse input. The free AutoHotkey scripting host (**autohotkey.com**) lets you create scripts that simulate mouse movements and button presses, to automate programs that don't offer a regular scripting interface.

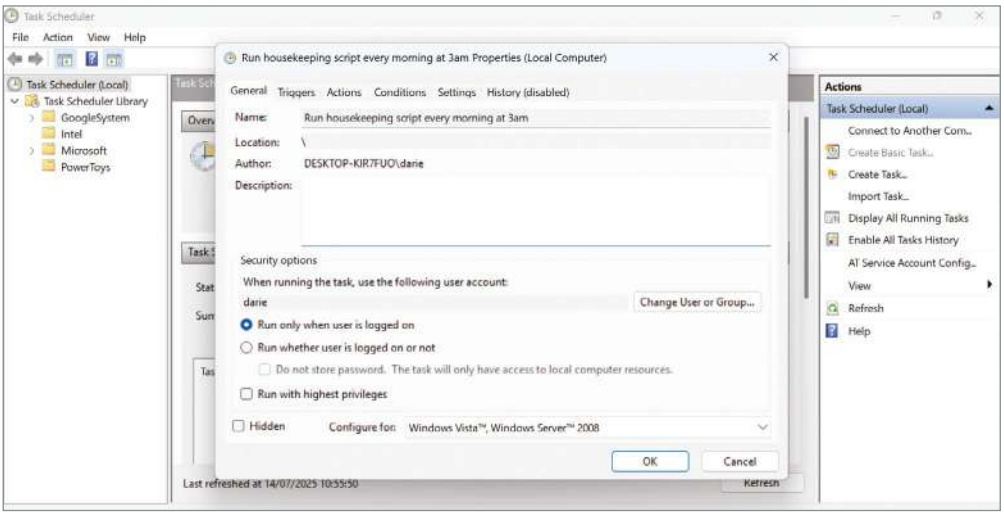
AutoHotkey can also be used to create custom keyboard shortcuts (hence the name). For example, you could program it to copy all the files from a specified folder to a backup destination every time you press Ctrl+Shift+B.

REMOTE ACCESS

If you're managing a network of multiple devices, setting up remote desktop access – so you don't need to physically visit different computers to find and fix potential problems – can be a real time-saver. Windows 10 and 11 Pro include Microsoft's business-grade Remote Desktop technology, but if you're looking for a solution that will work on Home editions of the OS, Microsoft Quick Assist could fit the bill. It's a free download from the Microsoft Store and lets users share a connection code with a trusted third party to grant desktop access.

For connecting to unattended computers – or non-Windows ones – you'll need to explore other systems. There are plenty of commercial remote-desktop tools that allow free personal use, such as RustDesk (**rustdesk.com**) and TeamViewer (**teamviewer.com**), but they may block you without warning if your usage strays into quasi-professional territory.

A fully free alternative is the open-source TightVNC (**tightvnc.com**). This works on all editions of Windows, plus macOS and Linux systems, but it doesn't use a central hub – so you may need to configure your router's firewall to allow direct connections from one computer to another, and set up port-forwarding rules if you want to enable remote desktop access over the internet.



ABOVE Task Scheduler runs programs and scripts at preset times automatically

GETTING YOUR BACK UP

Any IT administrator will tell you that backup is one of their most important responsibilities. Unfortunately, Microsoft has deprecated the useful Backup and File History tools that used to be integral features of Windows – presumably because it wants you to use OneDrive instead, and to pay for the online storage.

Still, there are plenty of alternative tools to choose from, many of them free. If you want to back up your network like a professional, one option we'd draw your attention to is enterprise backup specialist Veeam (**veeam.com**), which offers a free community edition of its software that can protect up to ten Windows and Linux clients – more than enough to cover a typical home network.

Veeam can back up not only critical files but complete system images too, which can save you a lot of time and bother in the event of a serious failure. As well as fully restoring a working system, Veeam images can be mounted as virtual machines, so you can easily dip into a past system state to check old files, applications and settings. Find out more and download it from **tinyurl.com/373veeam**.

For simpler, ad hoc file duplication, we'll also mention a lightweight tool called FreeFileSync (**freefilesync.org**). This tiny utility runs on Windows, macOS and Linux, and automatically replicates the contents of any specified folder to a set destination, such as a NAS appliance or external hard disk. It works very efficiently because it only copies new and updated data, and sync tasks can be triggered from a script or batch file. Note, though, that FreeFileSync is designed for mirroring, not archival: it doesn't keep older versions of updated files, so it's not a complete backup solution on its own.

Finally, one last piece of wisdom from the business world: don't blindly trust your backup software, but make a point of regularly checking backups, to see that all the latest files are there, and that you can copy them back and open them without issue. It's all too easy to configure an automatic tool that looks like it's doing the right thing – right up until the day when a computer failure or virus hits. ●

MAKE AN INCIDENT RESPONSE PLAN

Every business needs a cyber-incident response plan to ensure that any attacks are handled effectively and consistently. If you're looking after a home network, or providing informal remote support for friends and family members, you too can benefit from drawing up some simple instructions ahead of time. You might find it helpful to follow the same four-phase structure as recommended by the UK government for corporate response plans:

1 EVALUATE

What should your friends and family be looking out for? How can they identify an incident? You don't want to alarm them, but you don't want them to overlook suspicious behaviour either.

2 INFORM

Tell them the best way to reach you in a cyber-emergency and spell out exactly what you need to know – so hopefully when the call comes it will say something more illuminating than "the web page went funny".

4 COORDINATE

Set out what you want the person experiencing the suspected attack to do independently, without waiting for your response – and, for your own clarity as much as theirs, write down what you intend to do, too.

4 UPDATE

The first time you try to execute your plan you will inevitably run into unanswered questions and unexpected pitfalls – but if you learn from each incident and update your plan accordingly, over time it will become more and more watertight. Ideally, it's worth carrying out drills rather than waiting for a real attack.

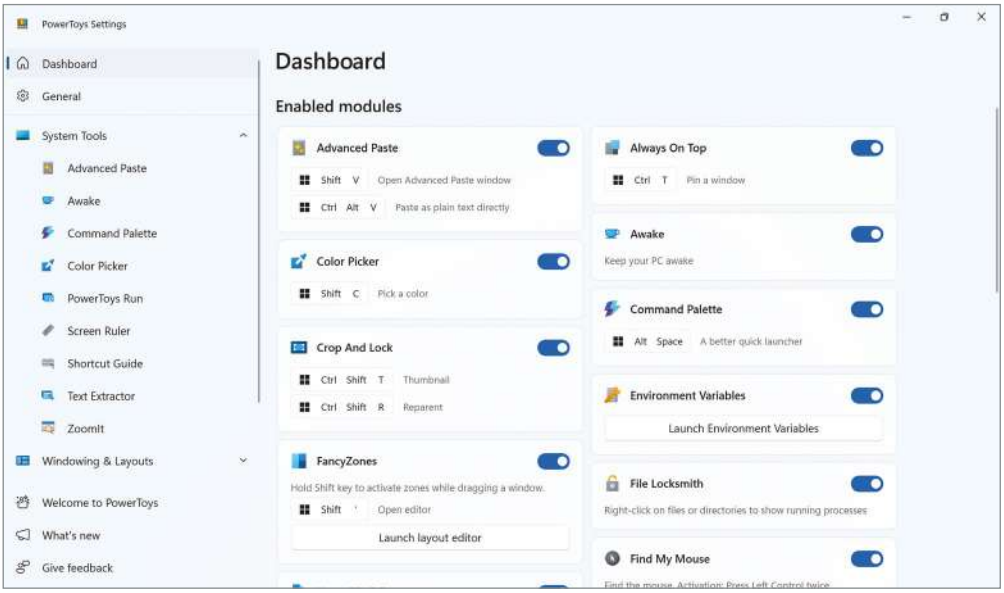
8 POWERTOYS YOU'LL USE EVERY DAY

MICROSOFT'S FREE UTILITIES FOR WINDOWS ADD ALL SORTS OF NEAT AND USEFUL FEATURES: NIK RAWLINSON PICKS OUT THE BEST

The Windows PowerToys date all the way back to the days of Windows 95. Those who were lucky enough to have internet access in those days could download a set of 15 little utilities that enabled them to tweak the Windows interface, customise their context menus, enhance CD-ROM features and personalise the operating system in various other ways.

Since then, the PowerToys suite has been through several iterations, with features appearing and disappearing over time; with Windows 10 it was relaunched as a set of open-source tools, distributed via GitHub and the Microsoft Store. It's also evolved from a collection of standalone utilities into a single download with a unified front end, from which you can easily activate, deactivate and manage all the various components.

You can install the suite from the Microsoft Store by searching for "Microsoft PowerToys". Once it's installed, launch "PowerToys (Preview)" from the Start menu to open the main PowerToys app. Don't worry about the "Preview" part – that's been there for many years. At this point it's little more than a jokey reference to the fact that the PowerToys are continually being developed.



The main PowerToys dashboard gives you an overview of enabled modules, along with a quick reminder of what each one does and a handy switch for turning individual features on and off. You can browse more deeply using the navigation list on the left, which divides the available features into various categories such as "System Tools", "Windowing & Layouts" and so forth. You can also bring up a quick-access mini-dashboard at any time by clicking the PowerToys icon in the System Tray; click the "More" button here to bring up the full dashboard.

ABOVE The main dashboard shows you each module and tells you briefly what each one does

There are currently 27 PowerToys to explore, with new ones appearing from time to time. Some have a narrow focus, such as the Hosts File Editor, whose sole function is updating the "hosts" file that's used for manually resolving IP addresses; others can help you handle a whole range of daily tasks more quickly and effectively. Here's our pick of the top eight PowerToys that almost everyone should find useful.

1 POWERTOYS RUN

PowerToys Run is an alternative app launcher to the Windows Start menu, which looks and works similarly to the Spotlight feature on macOS. You'll find it in the PowerToys app under System Tools. Once it's active, you can simply press Alt and Space together to bring up the Run window in the middle of your screen, then start typing the name of whatever program you want to run. PowerToys Run instantly starts showing results below the main Run window; key down to select one, or keep typing and just hit Return when the option you want is highlighted at the top of the list.

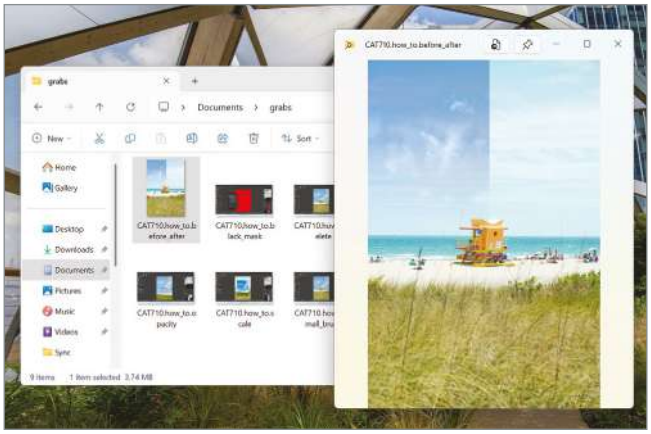
In fact, PowerToys Run is much more than merely an app launcher. As well as running programs, you can use it to search your files, run shell commands, visit web pages, perform maths operations and more. You'd be surprised how much more smoothly your work will flow when all of these tasks are rolled into a single dialog box – and best of all, you don't need to reach for the mouse every time you use it.

LEFT PowerToys Run gives you quick access to apps, files and information

2 PEEK

Peek emulates another long-standing feature found on the Mac – namely Quick Look. This handy feature lets you select any file in the macOS Finder, then hit Space to pop up an instant preview of images, PDFs, text documents and more.

Peek works in exactly the same way – the biggest difference is the keypress, as it requires you to hit Ctrl+Space to see the contents of whatever file is currently selected in the Windows File Explorer. Peek works with a huge range of file types, including text, images, Office documents, ebook files and even audio and video media. You can also use the cursor keys to step through a list of files while keeping the preview window open, so – for example – you can easily browse through a whole folder full of documents to find the one you want.



ABOVE Rather than opening files, you can use Peek to preview their contents quickly

3 TEXT EXTRACTOR

There are plenty of OCR tools out there, but their workflows can be fiddly (and they're certainly not all free). PowerToys Text Extractor provides an easy way to grab the text from any image visible on your screen.

Before using it, make sure that the image text you want to copy is visible and unobscured. Now press Windows+Shift+T to activate Text Extractor. You'll see an overlay appear on your screen; you can optionally select a language from here, in order to help Text Extractor recognise the text as accurately as possible, and choose whether you want text to be formatted as a single line or as a table.

Then just click and drag over text you want to capture. The text will be automatically recognised and copied to the clipboard, from which you can paste it wherever required.

4 IMAGE RESIZER

You can resize images in Microsoft Paint – or almost any graphic-editing package – but if you just want to shrink an image down for uploading to the web or attaching to an email, that's overkill. And if you want to resize a whole folder full of images at once, it's downright tedious to have to load, resize and save each one in turn.

The Image Resizer PowerToy lets you resize images directly from the File Explorer context menu. To use it, select one or more image files, then right-click and select "Resize with Image Resizer" from the context menu.

In the dialog that opens, select a preset size from the dropdown menu, or enter custom dimensions as required. You'll notice that there's also an option to reduce pictures that are larger than the specified dimensions, while not touching ones that are smaller. This is particularly handy if you want to shrink a set of differently sized images, without compromising the quality of smaller ones by blowing them up.

5 QUICK ACCENT

If you regularly work with foreign names or terms, getting the accents right is important. Windows lacks a simple, native way of typing accented characters, but Quick Accent adds one.

Once you've enabled Quick Accent, you can activate it by holding down the key for any character to which you want to add an accent, and tapping the left or right cursor or the space bar. For example, if you want to type "*sac à dos*", you might press and hold the "a" when you get to it, then quickly tap the left cursor. This will bring up the Quick Accent selector at the top of the screen, showing a variety of accented variants of the letter. Use the cursor keys to navigate to the one you want, then release the "a" key to add your chosen character to your document.

If you don't see the characters you're looking for, go into the Quick Accent settings in the main PowerToys app (you'll find it under "Input / Output") and select which of the 37 supported languages you're trying to use.

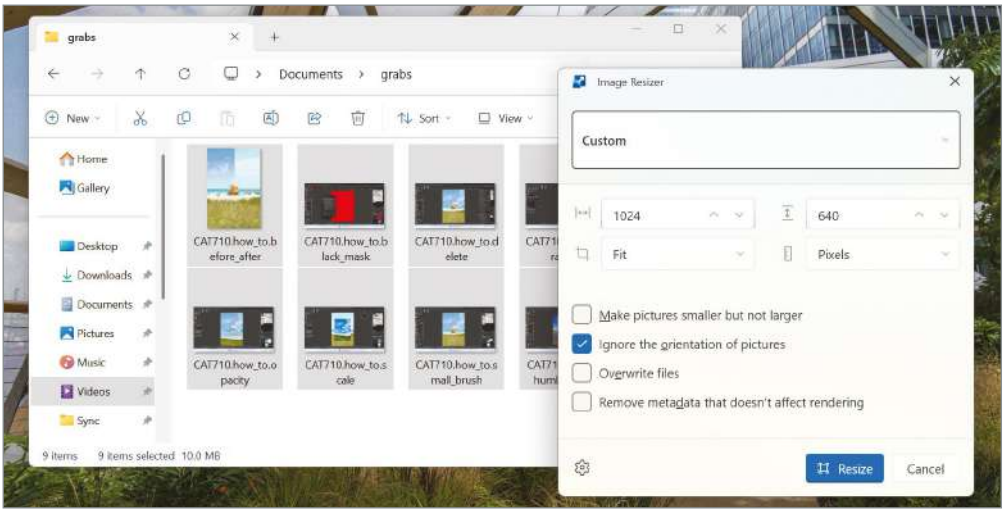
If you find that Quick Accent interferes with programs that use a long key press for some other function, you can also disable it in specific applications. Click on the Excluded apps to do so, then type in the name of the application you want to exclude. Note that partial matches will also be excluded, so if you type "notepad" then Quick Accent will be disabled in both the standard Windows application plus the third-party Notepad++ app, if you have it installed.

6 KEYBOARD MANAGER

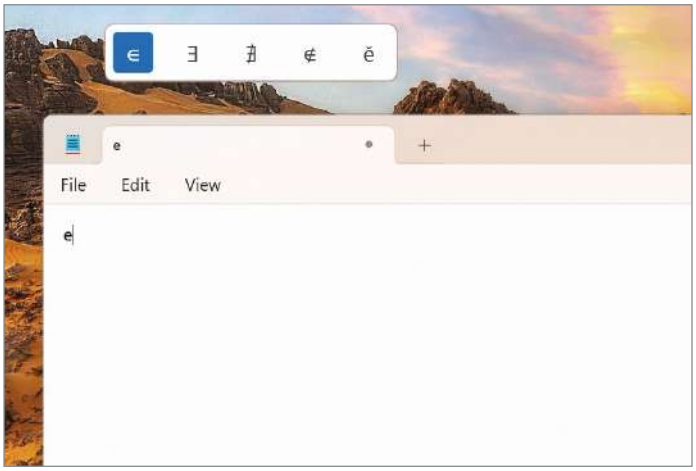
Quick Accent is fine as far as it goes, but sometimes you might want an easy way to enter other characters, such as a copyright symbol. Keyboard Manager lets you assign these characters to keys on your keyboard, or to key combinations using the Alt, Control, Shift or Windows keys. You can also create string shortcuts, so that pressing a particular key combination inserts a whole predefined passage of text.

To remap a single key on your keyboard, go to Keyboard Manager's settings page (also located under "Input / Output"), then click "Remap a key". In the dialog that opens, click "+ Add key remapping", then click Select in the first column and either press the key you want to remap or select a key from the dropdown menu beneath it. Now, using the dropdown menu in the "To send:" column, choose whether you want this key to trigger a different key or shortcut, or to insert a snippet of text.

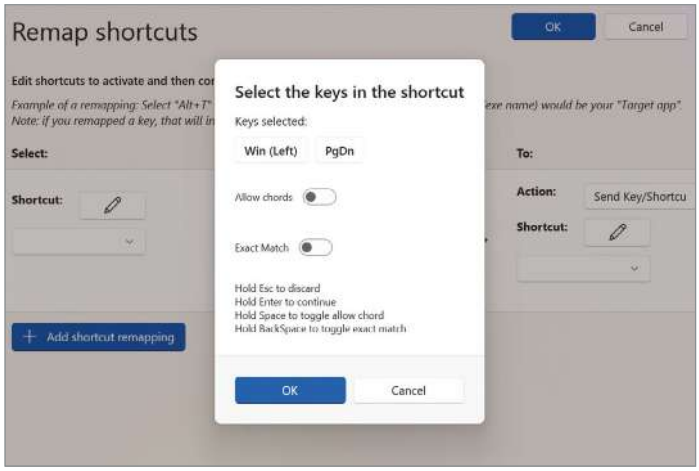
You can also remap existing shortcuts. In our case, our keyboard doesn't have a dedicated Print Screen button, so we'd like to assign that function to a different key combination. We can do this by selecting "Remap a shortcut" in the Shortcuts section, followed by "+ Add shortcut remapping".



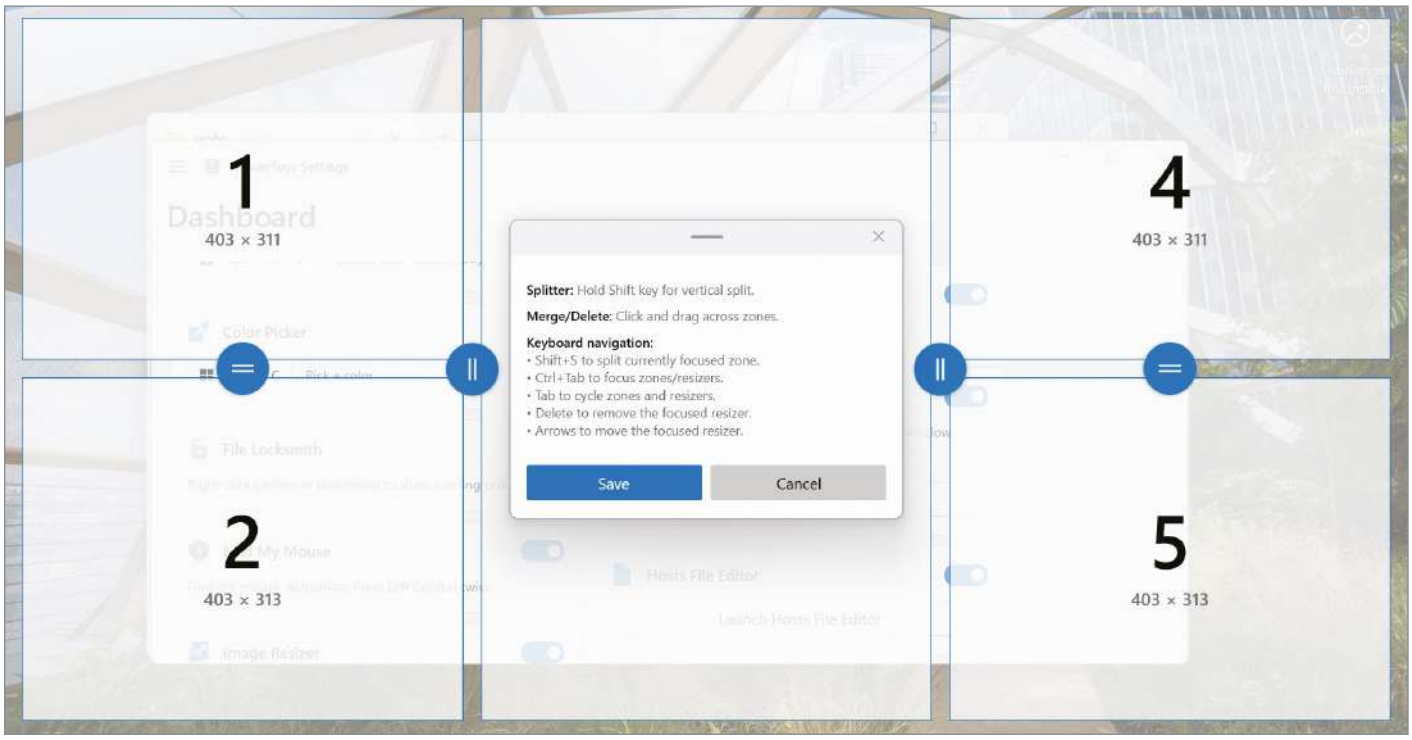
ABOVE Image Resizer adds a resizing tool to the File Explorer menu



BELOW LEFT Quick Accent makes adding accented characters easy



BELOW RIGHT In Keyboard Manager you can remap single keys or combination shortcuts



We now need to click the pencil icon and press the key combination we want to remap – in our case, we've chosen Windows+PgDn, because the PgDn key sits close to where you'd normally find a PrtSc button. After doing this, we click OK, and select "Print Screen" from the dropdown menu on the "To:" side of the window. You could also hit the pencil button again and press the key you want to invoke, but we can't do that in this case as the whole point is that we don't have that key on our keyboard.

To the right, you'll see an option for "Target app"; the default setting is "All apps", meaning this substitution will apply everywhere in the operating system, but if you want to confine the remapping to a single program, you can enter it here. You'll need to use the process name, rather than its friendly name – so Microsoft Word, for example, is winword.exe, Teams is ms-teams.exe and so on. You can check the names of running processes in the Task Manager.

You can remap almost all Windows shortcuts, but not Ctrl+Alt+Delete – nor Windows+L, which locks the screen. Microsoft also warns that if you try to reassign the Windows+G shortcut, it might still open the Xbox Game Bar. If this is a problem for you, you can disable the Game Bar by opening the Windows Settings app, then clicking on Gaming, then Game Bar and turning off the switch beside "Allow your controller to open Game Bar".

7 MOUSE UTILITIES

As computer displays get bigger (and more numerous), it can be easy to lose track of your mouse pointer. Mouse Utilities helps you quickly locate the cursor whenever you need to, by shaking your mouse, pressing Ctrl twice in quick succession, or using a custom keyboard shortcut. The screen will momentarily go dark, leaving just a light patch around the pointer to highlight its position.

That's not all Mouse Utilities can do. If you've ever recorded your screen, you may have realised that a viewer can't tell when you're clicking the mouse button. Mouse Utilities can be set to display a coloured circle around the pointer when you click, making it easy for others to see what you're doing. It's a simple but valuable tool, whether you're putting together an instructional video or capturing some on-screen action for tech support.

While Mouse Utilities is great for desktop productivity, the mouse-shake detection can sometimes trigger while you're playing a game. If that gets in your way, go into the Mouse Utilities settings in the main PowerToys app and you'll find an option to disable it when your computer is in game mode.

ABOVE FancyZones lets you define your own boundaries for more flexible window layouts

BELOW Mouse Utilities makes it easy to locate your mouse pointer

PowerToys Settings
Mouse utilities
Activation method
Press Left Control twice
Press Right Control twice
Shake mouse
Custom shortcut
Shake minimum distance
The minimum distance for mouse shaking activation, for adjusting sensitivity
Shake interval (ms)
The span of time during which we track mouse movement to detect shaking, for adjusting sensitivity
1000
Shake factor (percent)
Mouse shaking is detected by checking how much the mouse pointer has travelled when compared to the diagonal of the movement area. Reducing this factor increases sensitivity
400
Do not activate when Game Mode is on

8 FANCYZONES

We're big fans of the window-snapping features in Windows 11, which help you organise active windows to ensure the best use of your display. If you find the preset locations limiting, however, FancyZones lets you define your own, and apply preset layouts so you can always have your applications appear where you want them at the start of the working day.

To use it, hold down the Windows key and the Shift button, then press the apostrophe key to open the FancyZones Editor. You can now select from one of the existing layouts, or create one from scratch by clicking "+ Create new layout". Give your custom layout a name, then choose between a Grid layout, in which windows nudge up against their neighbours without encroaching, or Canvas, where windows can overlap.

Click Create again, then use the drag handles to resize the suggested zones; you can also use the arrows to move a focused resizer around, or remove any you don't want. You'll notice that moving your mouse within an existing zone repositions a horizontal bar – this indicates where the zone will split if you click, to create panels above and below.

Reviews

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Dell 14 Premium

Dell's Premium line picks up where XPS laptops left off, with the option for RTX 4050 graphics to give extra lift

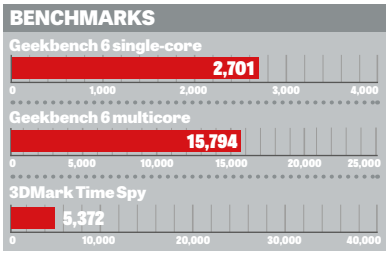
SCORE ★★★★☆

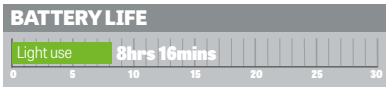
PRICE As reviewed, £1,833 (£2,199 inc VAT) from dell.co.uk

Like the Dell 16 Premium overleaf, the Dell 14 Premium carries on the XPS formula with little changed beyond the branding; regular readers will know that Dell has simplified most of its product ranges into plain Dell, Dell Plus and Dell Premium, using the good, better, best principle. Professional products then see the word "Pro" squeezed in.

But all this means that the Dell 14 Premium is really the 2025 update to last year's Dell XPS 14 (*see issue 356, p48*), with its most obvious rival being the 14in MacBook Pro (*see issue 364, p50*). Where the XPS 14 used Intel's Lunar Lake chip, geared towards efficiency, the 14 Premium packs an Arrow Lake H chip. This can be paired with an Nvidia RTX 4050 GPU, something last year's model wasn't capable of due to the limitations of the Lunar Lake chip design.

The Dell 14 Premium starts at £1,499 inc VAT, which includes a Core Ultra 7 255H, integrated Arc 140T graphics, 16GB of RAM, a 512GB SSD and a non-touch IPS panel with a 1,920 x 1,200 resolution (Dell has taken to calling this 2K, perhaps because it sounds better). For our review sample it ups the ante with RTX 4050 graphics, 32GB of integrated memory and a 1TB SSD. This takes the price to £2,199 if you configure it, but look out for deals on Dell's site and with other retailers.





Graphics chops

As your biggest decision is likely to be integrated graphics or discrete, let's tackle that first. 3DMark gives our first indication of how far Intel's Arc graphics have come: the Dell's result of 5,372 isn't light years away from the 4,226 of the Acer Aspire Vero (*see p60*), which relies on the Core Ultra 7 255H's integrated GPU.

This pattern continues in real games. Take *Civilization VII* at 1080p High settings: the Dell 14 Premium returned 93fps to 77fps for the Acer. *Shadow of the Tomb Raider* at 1080p Highest: 50fps versus 45fps. It was only in *Cyberpunk 2077* that Nvidia's chip showed its chops, with 38fps at 1080p Ultra settings compared to 28fps.

ABOVE The Dell 14 Premium is a powerful laptop for creatives

"Nvidia's silicon does give it an advantage, and that could be the difference between playable and non-playable AAA games"

Ignoring the comparisons for a second, there's no doubt that having Nvidia's silicon and software package does give an advantage, and that could be the difference between playable and non-playable AAA games. Just don't imagine that you're giving up gaming by sticking to the Intel graphics.

Panel preference

You also have to decide between panels, and the OLED option is another thing the 14 Premium has over the MacBook Pro. Quite simply, it's gorgeous. Colour coverage went 16% beyond the DCI-P3 gamut in our

tests, so punchy doesn't even begin to describe the colours, and its accuracy is beyond rebuke with an average Delta E of 0.28. Viewing SDR content, we measured a peak of 351cd/m² at the centre, rising to 608cd/m² with HDR content. Films and games look spectacular, with the latter helped by a peak 120Hz refresh rate.

We haven't tested the IPS panel, but its main disadvantage is having 1,920 x 1,200 pixels versus 3,200 x 2,000 here. Dell says it covers 100% of the sRGB gamut but doesn't mention DCI-P3, so colours won't be as vivid, but a claimed peak brightness of 500cd/m² is reassuring.

The other difference between the two panels is power draw. Dell says the IPS panel consumes a maximum of 2.39W compared to 9.32W for OLED, and describes it as "power-saving" in its marketing. And this is a factor, because battery life isn't a strength: our test unit died after 8hrs 16mins of light use. Dell claims the IPS version with integrated Intel graphics lasts for up to 20 hours of Netflix streaming, while the GeForce-toting OLED option lasts up to 11 hours.

Weighty decisions

You also pay a weight penalty by opting for OLED and GeForce graphics, with the IPS version weighing 1.63kg with Intel inside and 1.78kg if you upgrade to Nvidia. The OLED version is 1.72kg without RTX 4050 graphics, 1.83kg with. It doesn't make any difference to the chassis, though, which is 18mm tall at the rear to ensure plenty of room for the fans and cooling.

In terms of styling, the Dell 14 Premium looks serious and businesslike whether you choose the Graphite or Platinum finishes, which are honestly rather boring at this point. With the new Surface Laptop (*see issue 371, p54*) coming in Sapphire and even Apple adding a Sky Blue option for this year's MacBook Air models, this is an area where Dell needs to catch up.

Dell sticks with its opinion-splitting borderless trackpad. I've yet to embrace the solid strip beneath the keyboard, as it takes a while to work out exactly how to right-click on something, for instance, but you'll pick it up after a while. And it's still an accessibility nightmare, as is the lack of physical function keys along the top of the keydeck.

While the keyboard itself is decent enough, as someone used to mechanical keyboards I struggled with the limited travel and responsiveness of the 14 Premium's keys. If this is going to be your primary computing device, however, you'll almost quickly grow accustomed to it, I'm sure.

Port promise

Some will complain about the lack of USB-A ports on the 14 Premium, but frankly, it's 2025. At some point, older, slower interfaces will be retired, and it's time. There are lots of adapters out there to convert USB-A to USB-C, and an extra £16 at the time of ordering buys a mini-hub dongle with USB-A and HDMI ports that can plug into one of the three Thunderbolt 4 ports on the device. All three provide power delivery and DisplayPort out, with up to four monitors supported overall. You also get a microSD slot and a 3.5mm combo jack. All in all, it's a solid port selection for a device this small.

I'm less impressed by the webcam. The 1080p IR unit itself is perfectly good, and gets up to 30fps 1080p video, which is great for video calls and meetings. My problem is the lack of a privacy shutter: again, it's 2025, and this should be the default on a premium laptop. On the plus side, there are top-firing speakers, which isn't always a sure thing on a 14in laptop.

ABOVE Choose the OLED panel and you'll be rewarded with stunning images

Speed where it matters

There were no great surprises when it came to testing, with Dell's Performance mode and fan setup getting the most out of the Core Ultra 7 255H processor. Take Geekbench 6, where a 2,701 score in the single-core test drifts a long way behind the 3,807 from the M4 in the MacBook Pro, only for Intel's chip to retake the lead in the multicore section with 15,794 compared to 15,114.

I didn't even mention the MacBook in the gaming section, but you can probably guess that it's consistently slower in every test (for example, 39fps in *Civilization VII* and 36fps in *Shadow of the Tomb Raider*). Relative performance in creative apps very much depends on the tasks. For example, in the Blender Monster test the Dell scored 910 to the MacBook's 396, Handbrake rendered our video at 51fps compared to 66fps, while in PugetBench for Creators Photoshop Apple reversed the trend with a stonking 10,542 compared to 7,583.

"Should you buy the Dell 14 Premium? If you're after a slim 14in laptop that packs a GeForce chip, then it's the standout choice"

Worth the Premium?

So, should you buy the Dell 14 Premium? If you're after a slim 14in laptop that packs a GeForce chip, then it's the obvious choice. Don't expect gaming miracles, but if you keep the resolution to 1080p and detail settings high then you can play pretty much any game out there. It's also a powerful choice for creative tasks, and if you're willing to pay the penalty in terms of price and battery life then your daily work will look simply fantastic on that 14.5in OLED panel.

I do have niggles. The design is staid, there's no privacy shutter, and while the warranty is on-site (after remote diagnosis and 1-2 business days) it's only for a year. Choose three and that adds almost £300 to the already hefty price. It's still a great laptop, but not the standout option the XPS range used to be. **JOHN LOEFFLER**

LEFT You can buy the Dell 14 Premium in "Platinum" rather than "Graphite"

BELOW A businesslike design gives the laptop a serious look

SPECIFICATIONS

16-core (6 P-cores, 8 E-cores, 2 LE-cores) Intel Core Ultra 7 255H processor • Nvidia GeForce RTX 4050 graphics • 32GB LPDDR5X-8400 RAM • 14.5in 120Hz OLED touchscreen, 3,200 x 2,000 resolution • 1TB M.2 PCIe Gen4 SSD • Wi-Fi 7 • Bluetooth 5.4 • 5MP IR webcam • 3 x Thunderbolt 4/USB-C 4 • microSD card reader • 3.5mm combo jack • 70Wh battery • Windows 11 Home • 320 x 216 x 18mm (WDH) • 1.7kg • 1yr on-site warranty

Dell 16 Premium

The Dell 16 Premium holds its own against even the 16in MacBook Pro, with creative and gaming skills aplenty

SCORE ★★★★☆

PRICE RTX 5060, from £2,083 (£2,499 inc VAT) from dell.co.uk

Thanks to its larger body, the Dell 16 Premium – the model formerly known as the Dell XPS 16 (*see issue 357, p50*) – can pack up to an RTX 5060 GPU compared to the RTX 4050 found in its 14in sibling. In fact, the chassis can cope with an RTX 5070, which is what Dell sent us for testing – but that's not on offer in the UK. Like the Dell 14 Premium, the 16 uses Intel's Core Ultra H series chips and that means cores aplenty, going right up to a Core 9 Ultra 9 285H.

If you're paying this much for high-end silicon it makes sense to use Dell's Ultra Performance settings, which add fan noise but also a welcome 10% (sometimes more) bump up in speed. With this setting in place, the Dell 16 Premium romped to 11,409 in 3DMark Time Spy, 92fps in *Bordlerlands 3* and 32fps in *Cyberpunk 2077* – both at its most punishing settings at 1080p. That's roughly a 15% improvement compared to last year's RTX 4070-toting Dell XPS 16.

Choose your graphics settings wisely and you'll be able to play games at the 4K native resolution of our tested screen (we advise against choosing the 1,920 x 1,200 IPS panel across a 16.3in diagonal). Its colour coverage isn't as stunning as the 14 Premium's, with 80% of the DCI-P3 gamut under its spell, but colour accuracy remains excellent, it hit 572cd/m² in our HDR tests and will look fantastic whether you're creating animations or watching films. The speakers are great, too.

The downside is battery life, where both OLED panels and Nvidia GPUs take their toll. With a maximum battery life of about nine hours, according to Dell, this laptop can't keep pace with the 16in MacBook Pro, which lasted about 20 hours in our tests. The Dell 16 Premium struggled past five hours of mixed use, and 2hrs 30mins under heavy load at best.

The MacBook with an M4 Pro outperforms the Dell 16 Premium in the single-core Geekbench 6 test, but when it came to more real-world creative workloads Apple's flagship only won out in our PugetBench Photoshop test. Otherwise, the RTX 5070 GPU in our 16 Premium coupled with Intel's finest won out, whether in Premiere, Blender (where it was almost twice as fast) or Handbrake.

There's plenty of storage on offer here, too, with options ranging from 512GB to 4TB. Dell's upgrade prices are less punitive than Apple's, but you'll still pay an extra £400 to move from 1TB to 4TB. You can also choose between 16GB, 32GB or 64GB of RAM, but this is tied to your choice of CPU.

Design-wise, there's little difference between the Dell 16 Premium and the Dell XPS 16 it replaces. The same borderless trackpad and keyless function bar remain from the XPS and, for the most part, the form factor is essentially unchanged. That includes the touchbar, as I mention (and criticise for its lack of accessibility) in the Dell 14 Premium review. Likewise the borderless trackpad, although once you learn exactly where its active area is it works pretty well.

There's little to say about the keyboard that's either good or bad, but observe the lack of a number pad. This frees up space for a pair of two top-firing speakers, which provide good but not spectacular audio.

There's no USB-A port, with two Thunderbolt 4/USB-C 4 ports on the left and another on the right, alongside a microSD card slot and 3.5mm combo jack. As with the Dell 14 Premium, the 1080p camera is a fine inclusion (and great for Windows Hello logins) but lacks a physical privacy shutter.

Despite my criticisms, and the battery life, there's no escaping the fact that this is an exceptionally well-built laptop. If you're a creative professional then you'll love everything from the power on tap to the OLED panel, something Apple simply can't match. **JOHN LOEFFLER**

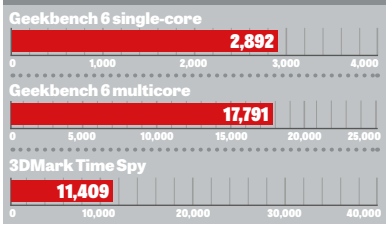
ABOVE The 16in OLED panel makes HDR content look fantastic

PC PRO RECOMMENDED

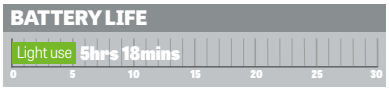
"This is an exceptionally well-built laptop. If you're a creative professional then you'll love everything from the power on tap to the OLED panel"

LEFT The keyboard and trackpad share the same strengths and weaknesses as the Dell 14 Premium

BENCHMARKS



BATTERY LIFE



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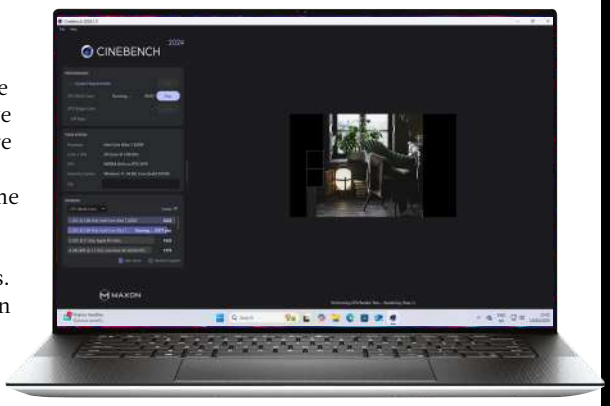
How we test

Laptops and PCs



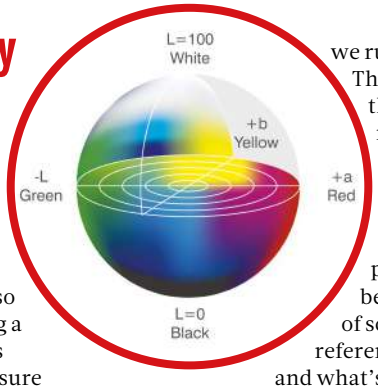
ABOVE **We put PCs and laptops through our intensive set of benchmarks**

We run a selection of benchmarks on all the PCs and laptops we test. Where possible, we use a cross-platform test so we can compare Windows and macOS machines, which is where both Geekbench and Cinebench come into play. Both push the CPU to its limit, exposing how well cooled a system is.

We run extra tests for Windows systems. We use PCMark 10 to benchmark systems in office tasks, content creation and basic tasks such as web browsing and video calls. We also run 3DMark Time Spy and *Shadow of the Tomb Raider* as a minimum. We test laptops and PCs that include discrete graphics with a range of games, such as *Metro Exodus Enhanced* and *Dirt 5*.

For laptops, we test battery life with Wi-Fi on and the screen brightness set to 150cd/m². We fully charge the laptops and drain them until they reach 5%. For Windows laptops, we will use a mix of PCMark 10's light-use and video-based tests, or a web surfing benchmark where a laptop automatically visits sites until the battery dies. We also use this test for MacBooks.

Screen quality



LEFT **We use a Display i1 colorimeter to measure sRGB gamut coverage and Delta E**

In each laptop, phone, tablet and monitor review, you'll see our conclusions about the screen quality. Some of this will be subjective, but we also test each screen using a X-Rite Display i1 Plus colorimeter. We measure maximum brightness, colour accuracy and (for monitors) consistency – there may be a difference in, say, brightness from the middle and the edges of the panel.

We also measure Delta E, which is a guide to how accurately panels display colours. Anything under 1 is excellent and likely to be difficult for the human eye to distinguish; between one and two is still strong; above this suggests a panel that you shouldn't trust for colour-accurate photo editing.

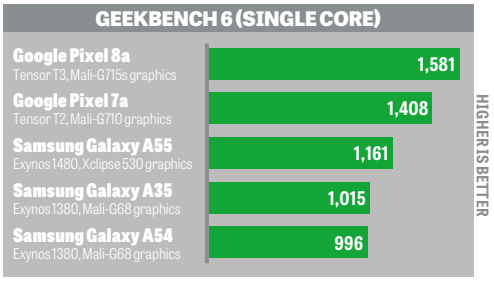
Phones and tablets

We run a selection of publicly available benchmarks on all the phones and tablets we review. First, we run Geekbench 6. This is a good test of the processor and memory in particular, and include both a test for single-core and multicore performance. See below for a selection of scores to provide a reference of what's good... and what's not so good.

We also run 3DMark Wild Life test to give a measure of gaming performance.

We test tablet battery life by playing a full-screen video until the battery runs out with the device. To simplify the test, we use Airplane mode. We set the brightness to as close to 150cd/m² as we can get in the device's settings. We also put phones through a set of real-world and labs-based tests.

BELOW **We play a video with the screen set to 150cd/m² to test battery life**



What our awards mean

Recommended
This, quite simply, is a product we recommend you buy – if it meets your needs.

A-List
The best buy in its category right now. The product will also feature on our A-List, starting on p14. It's updated each month.

Labs Winner
Each month we run a group test, or Labs. This product has managed to beat all others to top position.

Tinyurl.com links

Throughout the magazine you'll see **tinyurl.com** shortcuts. Enter these into the address bar of your browser and it will take you to a particular page, which will either be too long or awkward for us to publish or will take you to the precise shop from which to buy. If it's Amazon, note that we may have an affiliate deal in place so we will receive a commission from each sale. This will never affect our verdict of a product, and if another reputable vendor is selling the product cheaper then we will use that instead.

Prices will vary

Prices we publish are correct on the day we publish, but we often see prices change, especially on sites such as Amazon. However, we do work with British PC retailers to ensure the prices we quote for their systems are correct. If the price isn't being honoured, contact us via letters@pcpro.co.uk.

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LN148982

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Threadripper 7960X
128GB DDR5
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TECH HEART & SOUL | SCAN

HP EliteBook Ultra G1i

A slim and stylish business laptop with a standout webcam, OLED panel and software, and the price is surprisingly competitive

PC PRO RECOMMENDED

SCORE ★★★★★

PRICE As reviewed, £1,360 (£1,632 inc VAT) from hp.com

There's little doubt who HP has in its sights with the EliteBook Ultra G1i. This 1.2kg laptop is for the executive on the go, someone who needs a lightweight travel companion that looks as good in the boardroom as it does in sales meetings. The advert almost writes itself.

HP achieves this thanks to a compact and slender magnesium chassis finished in dark, matte blue. It's different without being ostentatious, making the Dell 14 Premium (*see p50*) look almost drab by comparison.

This is despite the fact that Dell sacrifices practicality for style with its light-up row of function keys and invisible touchpad while HP stays on the right side of practical by sticking to a physical row of keys at the top. These are finished in a subtly different hue that again adds to the style. HP also includes a USB-A port along with the trio of Thunderbolt 4/USB-C 4 connectors (and 3.5mm combo jack).

Key thinking

I don't normally talk about keyboards' backlighting, but HP has done a great job here. Pressing F5 flicks between off and two brightness levels, but the winning touch is how well the light shines through the keys to make it easy to see each one in dark conditions.

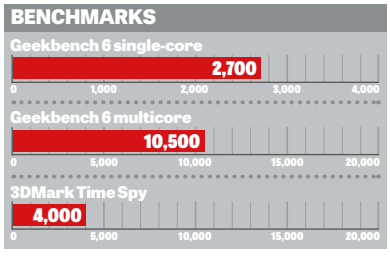
When it comes to typing, the keyboard is less stunning. No doubt HP has deliberately aimed for short, punchy key travel, but to me it feels too abbreviated, too harsh. And where the laptop keyboard master, Lenovo, often separates out the cursor keys in its ThinkPads, here the up/down keys are squeezed in by making them half height – and the function is doubled with PgUp and PgDn. None of this is a travesty, but I prefer Lenovo's approach and find I touch-type more quickly on its laptops.

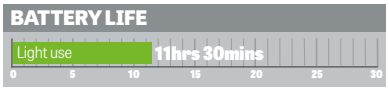
A gigantic touchpad measuring 138 x 87mm sits below, making it ideal for Windows' multitouch gestures. It's haptic, and if you head into the MyHP app and enable "gesture control" the left and right edges become shortcuts for volume and brightness. You may be surprised by how quickly you grow to rely on these, if my experience is anything to go by.

ABOVE This is a Copilot+ PC, but HP adds its own AI Companion, too

"This is for the executive who needs a lightweight travel companion that looks as good in the boardroom as it does in sales meetings"

BELOW It's always reassuring to see a USB-A port alongside USB-C connectors





Positive display

Then we come to the screen, which is the most impactful I've used on a business laptop. It's a top-quality OLED panel with a super-sharp 2,880 x 1,800 resolution, variable refresh rate up to 120Hz and 100% coverage of the DCI-P3 gamut. With an average Delta E of 0.5 you can trust the colours you see, too.

Brightness peaks at 402cd/m², but as always with OLED panels you can easily get away with something closer to 150cd/m², the setting at which we test battery life. On IPS screens this usually looks a trifle dim, but here I entirely forgot to switch it back to full brightness after I finished testing.

Thanks in part to the OLED panel, which consumes more power than an IPS panel, it "only" lasted for around 15 hours of light use. A great score on paper, but beware how high you push the screen's brightness: I found the battery life dribbled away more quickly than I expected in real-world usage. I suspect most people will bring the 310g power adapter with them, as this takes the laptop from empty to 48% in half an hour.

Question of speed

You can order the EliteBook Ultra G1i with either a Core Ultra 7 256V or Core Ultra 7 258V; they're identical CPUs, the difference being that the 256V includes 16GB of RAM, the 258V 32GB. HP sent the latter configuration, which also doubles the SSD size to 512GB from the base. I'm not sure why anyone would choose the lesser spec, as it only saves you £72.

The 258V performed predictably well in Geekbench 6's single-core test and predictably less well in the multicore section. This isn't a chip for anyone whose days are filled with demanding tasks that push the chip's eight cores to the limit; instead, it's designed for a "knowledge worker" who spends their time in Excel, PowerPoint and Teams.

Luckily for them, the webcam is simply outstanding. It pushes up to 4K, while the Poly Camera Pro software is a superb way to present a professional image to the world. For example, you can embed graphics showing your name and contact details or add sophisticated backgrounds that take advantage of the Core Ultra 258's powerful NPU.

The microphone and speakers are again top of the range. You can use this laptop for calls in busy environments without worrying about background noise, while I found myself listening to a whole playlist on Spotify without even thinking about switching to my Echo.

Perfect AI companion?

HP's AI Companion, exclusive to its Copilot+ PCs, is still in beta, but offers a slick way to analyse documents locally and then query them. For example, to create summaries and basic insights. In terms of powerful insights, it's a far cry from online services such as Adobe's new Acrobat Studio (which can almost act like a personal assistant to help you draw up a sales plan for a prospective client), but then again HP's service is free. Have a play and see how it can help.

There's another piece of software worth exploring: HP Wolf Security. This goes a couple of steps beyond most security packages by sandboxing every file you download or are emailed, for example by loading Word docs in a protected view. Before you can start editing or allow, say, macros to run, you have to actively remove the protection.

In some ways it's an excellent idea, and certainly protects against those threats that rely on users letting down their guard and opening docs without thinking. On the other hand, it's a colossal pain in the bottom that slows down your daily working. This is the eternal balance we face between security and convenience. But I did notice it slowed down some of my benchmarks: before I uninstalled Wolf, 3DMark Time Spy averaged around 2,800; afterwards, it was closer to 3,800.

ABOVE The gigantic haptic touchpad is ideal for Windows' – and HP's – gestures

"HP has done an exceptional job with the EliteBook Ultra G1i. Its price is competitive, and the screen, webcam and design are all outstanding"

ABOVE The EliteBook Ultra G1i comes with a one-year licence for HP Wolf Security

BELOW The 14in OLED panel is arguably the best we've seen on a business laptop

One year later

HP includes only a single-year licence for Wolf Security, and this ties in with the warranty: a meagre one year of return-to-base cover. After a couple of days using the laptop, an offer will pop up suggesting you upgrade your warranty. It's all very slick until you hit "Choose your plan now", at which point I was faced with a choice of 553 HP care packs each tailored to different products (including HP DesignJet scanners!) with no option to filter out the irrelevant cruft.

All of which means you're better off selecting this at the time of purchase, with the only option – that I could see, at least – being an extension to three years of on-site cover for £168 inc VAT. I would consider this, despite the evident high quality of HP's construction.

Nor is HP keen for amateurs to get inside this laptop and repair it themselves. Torx screws protect the base, and HP explicitly states that the battery is not user-replaceable. However, HP's support page is stuffed with information for professional repairers and IT teams, including an hour-long video that explains in detail how to replace everything from the battery to the speakers to the M.2 2280 SSD to the IR sensor board for the webcam.

One to buy

HP has done an exceptional job with the EliteBook Ultra G1i. Its price is competitive with other premium business laptops, even when you factor in the extended warranty, and the screen, webcam and design are all outstanding. The software package is equally strong.

One reason this laptop doesn't take an A List place is that pushing the screen up to full brightness had such an impact on real-world battery life, so I suspect I'd always end up bringing the power adapter with me on my travels. Nevertheless, this is a great laptop and one any executive would be proud to carry with them. **TIM DANTON**

SPECIFICATIONS

8-core (4 P-cores, 4 E-cores) Intel Core Ultra 7 258V processor • Intel Arc 140V graphics • 32GB LPDDR5X-8533 RAM • 14in 120Hz OLED touchscreen, 2,880 x 1,800 resolution • 512GB M.2 PCIe Gen4 SSD • Wi-Fi 7 • Bluetooth 5.4 • 9MP IR webcam • 3 x Thunderbolt/USB-C 4 • USB-A 3.2 Gen 2 • 3.5mm combo jack • 64Wh battery • Windows 11 Pro • HP Wolf Pro Security Edition (1yr) • 358 x 252 x 12.1mm (WDH) • 1.2kg • 1yr RTB warranty • part code B68RLEA#ABU

LG gram Pro (2025)

A successful update to the ever-slender 16in gram Pro, making it a top choice for large-screen lovers

SCORE ★★★★☆

PRICE £1,167 (£1,400 inc VAT)
from lg.com

You have to admire LG's consistency: from its first "gram" laptop a decade ago to the one sitting in front of me today, it has delivered the slenderest, lightest device it can using current technology. Throughout that time, it has judiciously chosen the best silicon for the job: never cutting-edge, but enough to deliver a smooth user experience and solid battery life.

This year, in the gram Pro's 16in iteration at least, that means Intel's Lunar Lake Core Ultra 200V chips, with my sample packing a Core Ultra 7 258V with 32GB of embedded DDR5 RAM. These eight-core processors are a match for the Ultra 255H in the Dell 16 Premium (*see p52*) in single-core tasks but fall some distance behind in tougher scenarios such as video editing and 3D modelling. That's reflected in the LG gram Pro's 10,860 return in Geekbench 6 multicore, compared to 17,791 for the Dell.

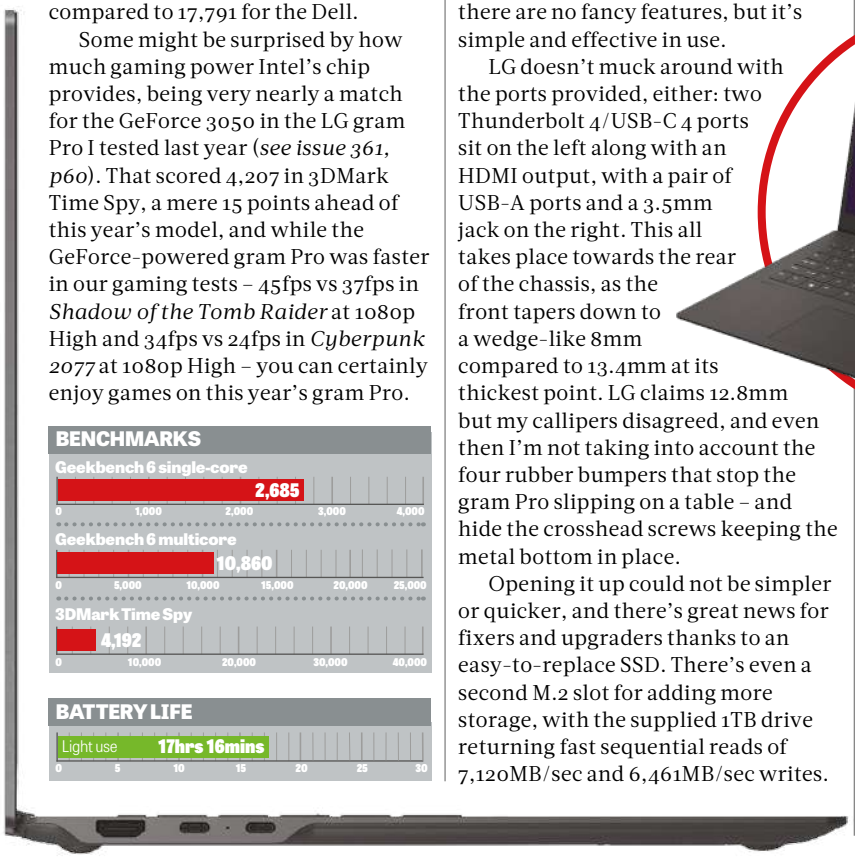
Some might be surprised by how much gaming power Intel's chip provides, being very nearly a match for the GeForce 3050 in the LG gram Pro I tested last year (*see issue 361, p60*). That scored 4,207 in 3DMark Time Spy, a mere 15 points ahead of this year's model, and while the GeForce-powered gram Pro was faster in our gaming tests – 45fps vs 37fps in *Shadow of the Tomb Raider* at 1080p High and 34fps vs 24fps in *Cyberpunk 2077* at 1080p High – you can certainly enjoy games on this year's gram Pro.

Perhaps not at the IPS panel's native 2,560 x 1,600 resolution, however. It's in your daily tasks where you'll appreciate all those extra pixels, and while OLED technology adds more richness I'm not going to complain about 97% coverage of the DCI-P3 gamut or an average Delta E of 0.37. Whites also look excellent at every brightness level, including this panel's peak of 446cd/m².

Any hybrid worker asked to use the LG gram Pro as their daily keyboard should also be happy with the decision. There isn't a huge amount of travel to each key, but a crisp action and well-sized tops – despite the inclusion of a number pad on the right – should mean you make minimal typos. It's also quiet, and a 131 x 83mm touchpad beneath makes navigation easy. It isn't a haptic touchpad so there are no fancy features, but it's simple and effective in use.

LG doesn't muck around with the ports provided, either: two Thunderbolt 4/USB-C 4 ports sit on the left along with an HDMI output, with a pair of USB-A ports and a 3.5mm jack on the right. This all takes place towards the rear of the chassis, as the front tapers down to a wedge-like 8mm compared to 13.4mm at its thickest point. LG claims 12.8mm but my callipers disagreed, and even then I'm not taking into account the four rubber bumpers that stop the gram Pro slipping on a table – and hide the crosshead screws keeping the metal bottom in place.

Opening it up could not be simpler or quicker, and there's great news for fixers and upgraders thanks to an easy-to-replace SSD. There's even a second M.2 slot for adding more storage, with the supplied 1TB drive returning fast sequential reads of 7,120MB/sec and 6,461MB/sec writes.



LEFT Two Thunderbolt 4/USB-C 4 ports and an HDMI output adorn the left-hand side

ABOVE Super slim, stylish and durable, the latest gram Pro is another winner for LG

"Opening it up couldn't be simpler or quicker, and there's great news for fixers and upgraders thanks to an easy-to-replace SSD"

ABOVE The quiet keyboard has space for a number pad

The memory is integrated into the CPU package, but elsewhere LG does a great job of labelling components such as the two downwards-firing speakers – a little light on bass but otherwise these do a fine job with music – and the 77Wh battery. They're all secured with screws; I couldn't see any sign of glue. Battery life is a strength here, too, with the LG lasting for over 17 hours in our light-use test. It even recharges quickly, going from empty to 70% in an hour.

There are a couple of irritations. I kept finding myself trying to touch the screen, but this is a non-touch panel. You also have to deal with annoying promos at the start, such as an amazing offer to buy McAfee Premium for £24.99 compared to its retail price of £29.99. Too generous, LG, too generous. And while it's good to see LG taking advantage of the Core Ultra's NPU with local AI chat, it's a shame it replied to my question in Korean. Still, I recommend you play around with LG's supplied software as there are some interesting tools tucked away.

Besides, the occasional rough edges are more than made up for by this laptop's long list of strengths – which include an excellent webcam and mics, not to mention the cost. While LG quotes a list price of £1,800, that appears to be so it can shout about a saving of £400 on its website: £1,400 is a much more reasonable amount, especially as you should factor in extra for an extended warranty beyond the supplied year of return-to-base cover. So it's yet another *PC Pro* Recommended award for the LG gram Pro – which should be no surprise. **TIM DANTON**

SPECIFICATIONS

8-core (4 P-cores, 4 E-cores) Intel Core Ultra 7 258V processor • Intel Arc 140V graphics • 32GB LPDDR5X-8533 RAM • 16in 120Hz OLED non-touch panel, 2,560 x 1,600 resolution • 1TB M.2 PCIe Gen4 SSDs • Wi-Fi 7 • Bluetooth 5.4 • 1080p IR webcam • 2 x Thunderbolt 4/USB-C 4 • 2 x USB-A 3.2 Gen 1 • HDMI 2 • 3.5mm combo jack • 77Wh battery • Windows 11 Home • 358 x 252 x 12.8mm (WDH) • 1.2kg • 1yr RTB warranty • part code: 16Z90TS-G.AU89A1

Honor MagicBook Art 14 (2025)

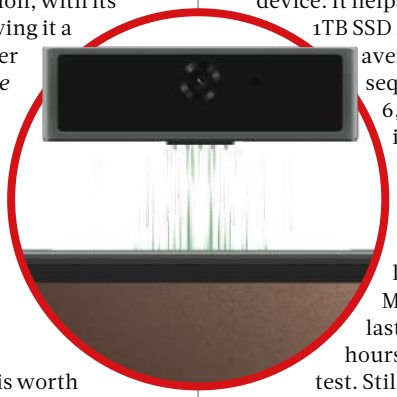
A classy laptop that packs a gorgeous, high-res OLED screen, bags of power and a pop-out webcam

SCORE ★★★★★

PRICE £1,250 (£1,500 inc VAT)
from honor.com

When I reviewed the Qualcomm version of the Honor MagicBook Art last year (*see issue 366, p52*), I mourned the fact it wasn't due to go on sale in the UK. With this 2025 update, Honor switches to Intel inside and brings it to the UK for £1,500 – a high price, but Honor tends to sweeten the deal with money-off vouchers and freebies.

Everything I loved about last year's model is still here, including an immaculate design. I tested the Emerald Green version, with its soft, matte finish giving it a real lift over the sober Dell 14 Premium (*see p50*). It's incredibly compact, barely larger than this A4 magazine, and weighs a mere 1kg. Using magnesium alloy achieves this, and the result feels well built with no obvious weak spots.



The OLED panel is worth protecting, with 3,120 x 2,080 pixels crammed into its 14.6in diagonal. If your eyesight is good enough you can even view two windows side by side. Honor's default colour profile is called Photography: this covered 97% of the DCI-P3 space with an average Delta E of 0.38, and with excellent whites I see no reason to switch to the untuned Native space. The panel can be pushed up to 504cd/m² in brightness, while refresh rates up to 120Hz add smoothness in Windows and games alike.

There is gaming potential thanks to Intel's Arc 140T graphics. It averaged a solid 30fps at 1200p in *Dirt 5* (High settings), 34fps in *Shadow of the Tomb Raider* (High, 1080p) and 33fps in *Cyberpunk 2077* (High, 1080p). Thermal management is a factor here. The Acer Aspire Vero 16 (*see p60*) uses the same chip but its bigger chassis means it can take advantage of the chip's full 28W TDP, while Honor's laptop is limited to 22W. Both can temporarily push up to higher wattages when required, but you can see the difference in games, where the Acer was often a few frames per second faster.

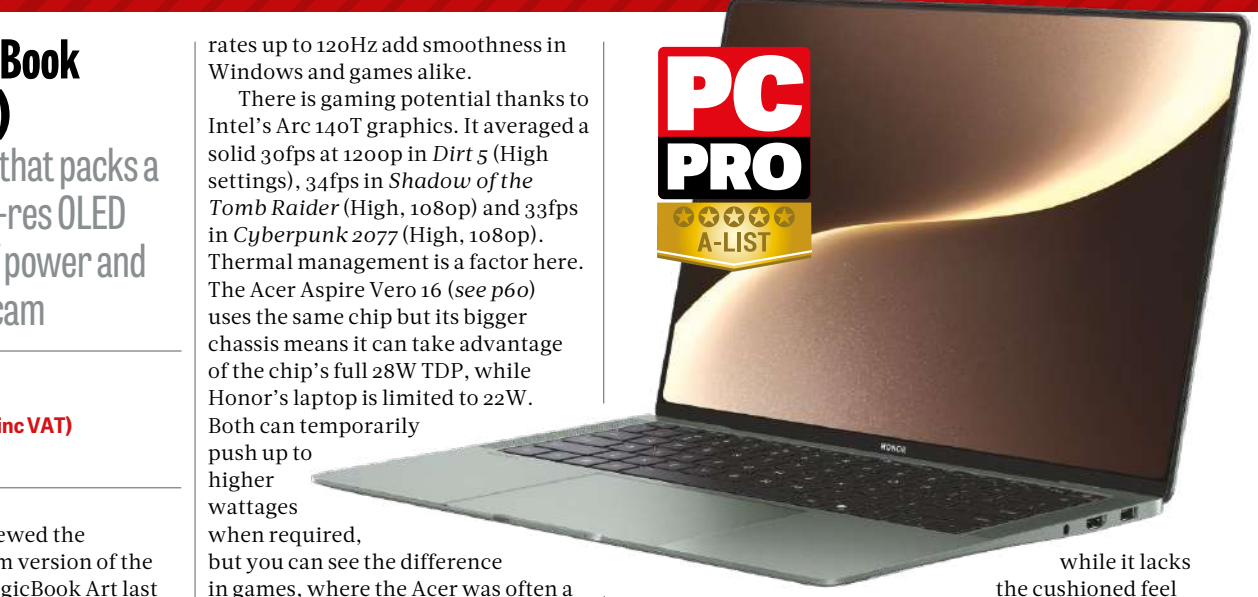
This handbrake effect can again be seen in the laptops' respective scores in Geekbench 6, but don't be fooled: you'll still find the MagicBook Art 14 incredibly fast when tackling demanding tasks, and I would be delighted to have the 16 Cores – six of them powerful P-cores – on tap if this was my on-the-go video-editing device. It helps to have a speedy 1TB SSD in tow, which averaged 7,114MB/sec sequential reads and 6,322MB/sec writes in CrystalDiskMark.

Some payback for the power and the OLED panel comes in battery life, with the MagicBook Art 14 lasting exactly 12 hours in our light-use test. Still, that's enough leeway to last most people's working day, and the compact 205g power supply took it from empty to 47% in 30 minutes and up to 77% in an hour. I can live with those figures.

It's a game of two sides when it comes to ports. On the right you have "legacy" connectors of USB-A, HDMI and a 3.5mm jack. On the left are two USB-C ports, one of which supports Thunderbolt 4, alongside a pop-out 1080p webcam. Press in and this springs into view, ready to be magnetically attached to the top of the screen. Quality is good enough for web calls, but its real advantage is privacy and being able to unclip it during a call and then point it the other way – for example, to show documents on a table.

The quality of the speakers is another welcome surprise, likewise the keyboard. Honor uses titanium in the mechanism, which perhaps contributes to the crisp sound accompanying firm presses, and while it lacks the cushioned feel of the best laptop keyboards there's a generous amount of downwards action. I would be quite happy using this for extended periods. Then there's the responsive, huge trackpad sitting below.

All told, this is a superb laptop. The RRP is high, but look out for voucher codes on-site that drop the price. My only amber flag is about the warranty, with Honor offering no options to extend the two years of return-to-base cover (although it's great to see two years, not one). Nor is it going to be easy to repair, with ten Torx screws guarding the base and only the battery and SSD easy to replace. This caveat aside, I have no hesitation in recommending this great piece of hardware. **TIM DANTON**



ABOVE The MagicBook Art has a superb OLED panel and packs plenty of power within

"Everything I loved about last year's model is here, including an immaculate design. It's incredibly compact and weighs a mere 1kg"

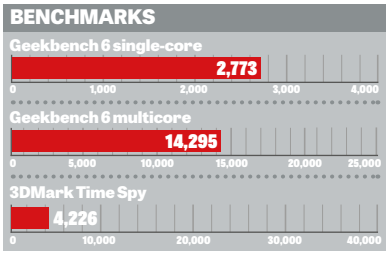
LEFT You can unclip and hide away the pop-out webcam to protect your privacy

BELOW The keyboard is comfortable to type on for long periods

SPECIFICATIONS

16-core (6 P-cores, 8 E-cores, 2 LE-cores) Intel Core Ultra 7 255H processor • Intel Arc 140T graphics • 32GB LPDDR5X-8400 RAM • 14.6in 120Hz OLED touchscreen, 3,120 x 2,080 resolution • 1TB M.2 PCIe Gen4 SSD • Wi-Fi 7 • Bluetooth 5.4 • 1080p webcam (hidden) • Thunderbolt 4/USB-C 4 • USB-C 3.2 Gen 2 • USB-A 3.2 Gen 1 • HDMI 2.1 • 3.5mm combo jack • 60Wh battery • Windows 11 Home • 317 x 224 x 11.5mm (WDH) • 1kg • 2yr RTB warranty

BENCHMARKS



BATTERY LIFE

Acer Aspire Vero 16 (2025)

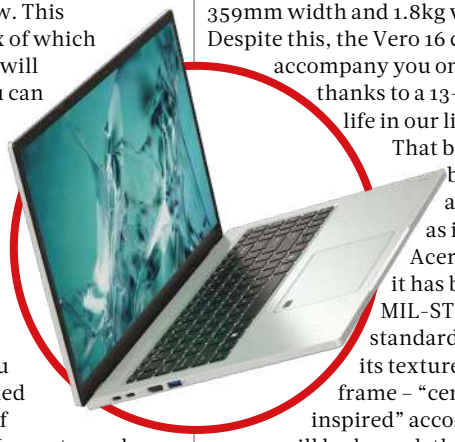
Eco-friendly materials help, but it's the likely longevity of the chassis and components that earn the Vero an award

SCORE ★★★★☆

PRICE £833 (£999 inc VAT)
from currys.co.uk

We're fans of anything that reduces waste, and that's the promise of the Acer's Vero range. Acer's marketing focuses on its use of post-consumer recycled plastics, but I would instead focus on its longevity, as I think this laptop could last for ten years.

For instance, it will be many years before Intel's Core Ultra 7 255H processor seems slow. This includes 16 cores, six of which are fast P-cores that will devour any task: you can see this in its 15,282 result in Geekbench 6's multicore section. Intel's integrated Arc 140T graphics are no slouch either, and thanks to a highly effective fan cooling system – not that you will often hear it called into action outside of games – the Aspire Vero returned strong averages of 39fps in *Shadow of the Tomb Raider*, 28fps in *Dirt 5* and 77fps in *Civilization VII*.



Those scores were all with High settings at the 16in panel's native resolution of 1,920 x 1,200. You might think that's too low, but at this price it's a reasonable compromise: text edges remain reasonably sharp, and the bright whites when the screen hits 413cd/m² offer good compensation. Colour coverage is fine, too, with 99% of the sRGB gamut and 79% of the DCI-P3 space within its grasp, while the average Delta E of 0.22 confirms that colour accuracy isn't an issue.

The bigger question for many users will be this laptop's sheer size. It isn't thick at 16.6mm, but you'll notice its 359mm width and 1.8kg weight. Despite this, the Vero 16 can accompany you on travels thanks to a 13-hour battery life in our light-use test.

That brings me to build quality, a real strength as indicated by Acer's claim that it has been tested to MIL-STD-10H standards. I suspect its textured plastic frame – "cement-inspired" according to Acer – will look much the same after many years of use, with multicoloured flecks to soften its looks.

Acer packs in the ports, with two Thunderbolt 4/USB-C 4 connectors on the left-hand side together with an HDMI output and USB-A port. Things calm down on the right, with only a 3.5mm jack to keep the second USB-A port company. Add Wi-Fi 7 and you should have everything you need for the next decade.

It's easy to replace the battery if and when it starts to degrade, with the crosshead screws securing the base numerous but straightforward to remove. The 53Wh unit looks tiny in the expanse of space available, and it's a shame Acer doesn't find space for a second M.2 slot, either. Still, the supplied 1TB drive is plenty for this laptop's likely usage, and sequential read and write speeds of 6,959MB/sec and 5,770MB/sec respectively are commendable from an affordable laptop.

The pair of down-firing speakers are less noteworthy, working best if they have a hard surface to bounce off, but they're fine for low-volume background music. Likewise for web calls, and here Acer accompanies the good-quality 1440p webcam with a physical shutter so you can be assured of privacy.

Acer adds its own PurifiedVoice and PurifiedView software, which are worth playing with in noisy or low-light environments. These use the 13 TOPS NPU built into Core Ultra 255H, but it doesn't meet Microsoft's Copilot+ PC criterion of 40 TOPS.

The camera doesn't support Windows Hello, but there's a fingerprint sensor built into the well-proportioned touchpad. With a glass-like coating, it's a pleasure to use. I'm more ambivalent about the keyboard, which lacks the travel and cushioning of the best and feels cramped despite this laptop's huge width – largely because Acer also finds room for a number pad.

The Acer Aspire Vero 16 isn't going to be crowned the world's best laptop any time soon, and if you're serious about buying a sustainable laptop I'd point you towards Framework's offerings. However, it does back up its use of materials with high build quality, eco-friendly packaging and a specification that should last for years. It's also relatively easy to repair compared to mainstream rivals. As we went to press, you could buy it from Currys for £849 rather than the list price of £999 – and at that price it's an excellent buy. **TIM DANTON**

ABOVE **Acer's Aspire Vero is built to last and fairly easy to repair**

PC PRO RECOMMENDED

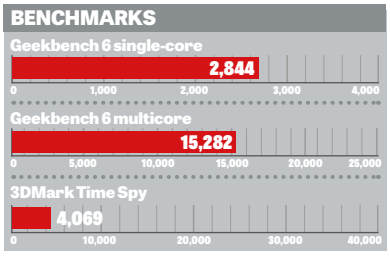
LEFT **The Vero's 16in display means this is a comparatively sizeable laptop**

"It backs up its use of materials with high build quality, eco-friendly packaging and a spec that should last for years"

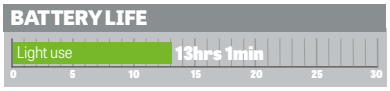
SPECIFICATIONS

16-core (6 P-cores, 8 E-cores, 2 LE-cores) Intel Core Ultra 7 255H processor • Intel Arc 140T graphics • 16GB LPDDR5X-8400 RAM • 16in 60Hz IPS non-touch display, 1,920 x 1,200 resolution • 1TB M.2 PCIe Gen4 SSD • Wi-Fi 7 • Bluetooth 5.3 • 1440p webcam • 2 x Thunderbolt 4/USB-C 4 • 2 x USB-A 3.2 Gen 1 • HDMI 2.1 • 3.5mm combo jack • 53Wh battery • Windows 11 Home • 359 x 247 x 16.6mm (WDH) • 1.8kg • 1yr RTB warranty • part code NX.JDKEK.001

BENCHMARKS



BATTERY LIFE



BELOW **Ports include two Thunderbolt 4/ USB-C 4 connectors and an HDMI output**

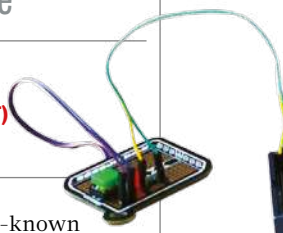
Argon One Up

The dream of a Raspberry Pi laptop is realised at last, with a bunch of great features if not a bargain price

PC PRO RECOMMENDED

SCORE ★★★★★

PRICE £400 (£480 inc VAT)
from argon40.com



Argon 40 is a well-known name in the world of Raspberry Pi upgrades and cases, but the One Up is more creative and ambitious than any accessory we've seen: it's a fully functional, bona fide Raspberry Pi laptop.

It's based on the Raspberry Pi Compute Module 5, and offers an M.2 slot for PCIe storage. It's being funded via Kickstarter, with the price set at around £450 for the Core unit with 8GB of RAM and a 256GB NVMe SSD, plus a GPIO breakout box, which we'll talk about below. I tried a pre-production unit, so the final version may have a slightly different finish and hopefully a few software tweaks, but there's more than enough here to get the idea.

Despite the low price, the One Up feels like a serious laptop. The cool, metallic, slate-grey finish is fingerprint-resistant, and the thin chassis feels good in the hand. The chiclet keyboard works well for this format, with a smart Raspberry Pi logo in place of the Windows key and a welcome UK layout option. The trackpad is serviceable and feels suitably responsive, accepting either a tap or a click for mouse clicks.

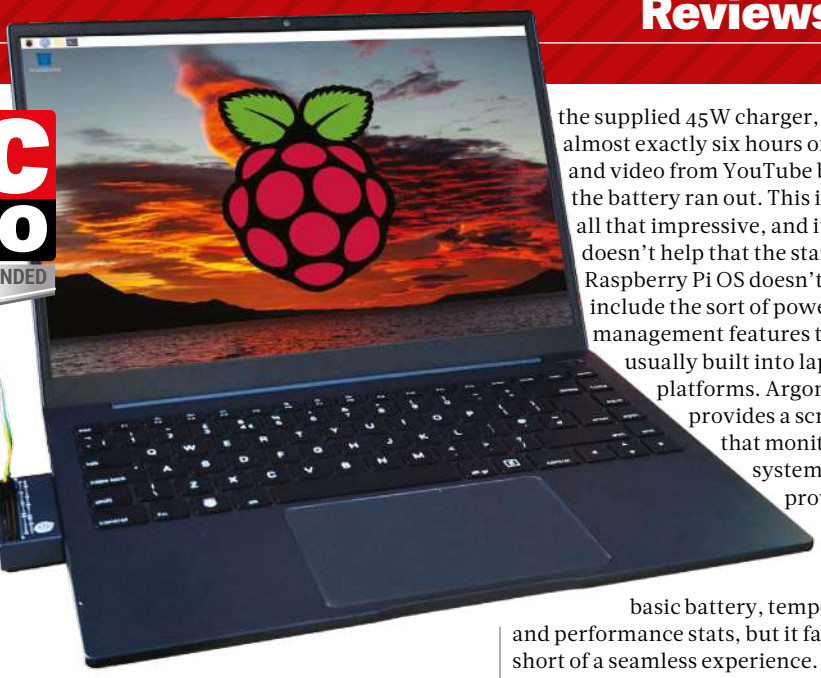
On the right-hand side of the laptop you'll find a Kensington lock point, two USB-A ports, a microSD slot and 3.5mm headphone jack. On the left there's a USB-C port for charging, a full-size HDMI port and two further USB-C ports, though these only run at USB 2 speed. Just above the screen you'll spot a built-in webcam with a physical shutter; this is fine for video calls, but it uses a USB connection, so it won't work with apps designed for the official Raspberry Pi Camera.

The 14in LCD screen is reasonably sharp, with a native resolution of 1,920 x 1,200, but a little lacking in brightness. It's perfectly usable, though, and the HDMI port means you can connect a second screen too: I hooked up a 4K monitor and couldn't set the resolution above 1,024 x 768, but I fed that back to the Argon 40 team and they're looking into it.

One thing I love about the One Up is the way it retains the immensely versatile GPIO connector, accessible via a supplied breakout box that connects to the two USB-C ports on the left-hand side. This is fully pin-compatible with a regular Pi board – the only gotcha is that the 3V and 5V pins are turned off by default, as a safety feature. Turn them on and all your existing add-ons and HATs should work immediately, as long as they're compatible with the Raspberry Pi 5 and its RP1 controller chip.

I also appreciate the inclusion of a 256GB NVMe SSD, supporting PCIe Gen3 speeds. Using dd to write the contents of the drive to /dev/null, I saw an average read speed of around 930MB/sec – excellent by Raspberry Pi 5 standards. In practice this ensures that the operating system feels beautifully snappy and responsive.

Finally, we come to a test that we don't normally get to try out for Raspberry Pi hardware – battery life. After fully charging up the unit with the supplied 45W charger, I got almost exactly six hours of music and video from YouTube before the battery ran out. This isn't all that impressive, and it doesn't help that the standard Raspberry Pi OS doesn't include the sort of power management features that are usually built into laptop platforms. Argon 40 provides a script that monitors the system and provides basic battery, temperature and performance stats, but it falls well short of a seamless experience. As an alternative, I tried installing Ubuntu 25.04 on the One Up: this ran well on the hardware and everything felt great, but it wasn't able to provide battery stats or show a charge indicator. Hopefully this will be addressed in an update.



ABOVE Despite the low price, the One Up feels well made and looks stylish

LEFT The GPIO connector means your existing add-ons and HATs should all work

I also measured the One Up's battery life while running s-tui and stressing all of the CPU cores. This time I was impressed to see the battery last 4hrs 29mins on a full charge – I'd expected it to burn through in two hours. I should, however, mention that during this test, the heatsink on the underside hit a very toasty 48°C; I suggest you do any complex, stressful tasks at a desk, not with the One Up on your lap.

"It's fair to say that not everyone needs or wants a Raspberry Pi laptop, but the One Up is something I've been dreaming of for years"

The Argon One Up feels expensive compared to a bare Pi board, but it's compact, neat and absolutely usable on the go. It's impressive that Argon 40 has achieved that without losing the Pi's signature GPIO interface – and because the whole thing is built on a standard Compute Module, there's every reason to hope you'll be able to upgrade it by simply slotting in a Raspberry Pi 6 or 7 board in the future.

It's fair to say that not everyone needs or wants a Raspberry Pi laptop, but the Argon One Up is something I've been dreaming of for years. I very much doubt we'll see a better portable Pi any time soon. **LES POUNDER**

BELOW The 256GB NVMe SSD means the operating system feels snappy in use

SPECIFICATIONS

Raspberry Pi Compute Model 5 (2.4GHz quad-core 64-bit ARM Cortex A76) • 2GB to 16GB LPDDR5X-7500 RAM • 14in 60Hz IPS non-touch panel, 1,920 x 1,200 resolution • 256GB M.2 PCIe Gen3 SSD • Wi-Fi 5 • Bluetooth 5 • 1080p webcam • USB-C 3.2 Gen 1 • 2 x USB-C 2 • HDMI 2 • 3.5mm combo jack • 55Wh battery • Raspberry Pi OS • around 320 x 220 x 18mm (WDH) • around 1.4kg • 1yr RTB warranty

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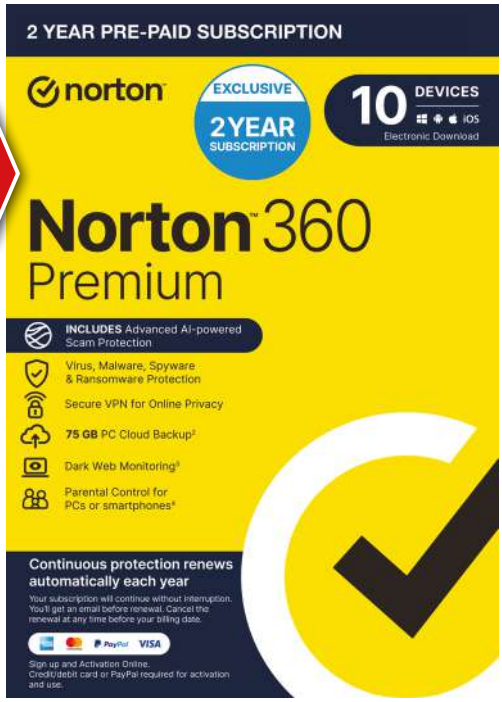
To round things off, Norton Password Manager generates and stores passwords across all your devices. All this for £19.99? Did someone say bargain?



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If you run into any problems, your licence includes free support from Laplink via a dedicated freephone number in the UK.

Lenovo Yoga AIO 9i Gen 10

The first all-in-one Copilot+ PC may not be perfect but it trumps the Windows competition by a distance

SCORE ★★★★☆

PRICE As reviewed, £1,917 (£2,300 inc VAT) from lenovo.com

PC PRO RECOMMENDED

ABOVE **A stunning screen and powerful CPU make the Yoga AIO a great choice**

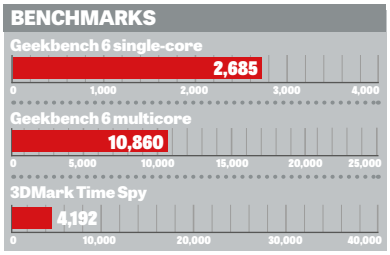
Right now, there are only two AIOs on the market that could give the Apple iMac a run for its money: this one and HP's announced but not yet tested OmniStudio X. Both meet Microsoft's criteria for Copilot+ PCs, with this Gen 10 version of the Yoga AIO 9i an update to the striking Gen 8 from 2023 (*see issue 353, p50*).

Lenovo has updated the CPU and GPU, with an Intel Core Ultra 7 258V and Nvidia RTX 4050 now in place. In day-to-day use, it's extremely powerful: if you need an all-in-one for office tasks, this won't break a sweat. I never heard the built-in fan come on in these workflows, unlike the Gen 8 with its Core i9-13900H chip. When it comes to single-core performance, the Core i9 and the Core Ultra 7 are neck and neck. It's multicore performance where the Core Ultra 258V suffers, due to its eight cores compared to 14 in the i9-13900H: this meant it scored 518 in Cinebench 2024's multicore test compared to 986. It's the same story in Geekbench 6, with the last-gen Yoga AIO earning 13,948 and the latest-gen only 10,627.

LEFT **The U-shaped stand makes it look like the screen is floating**

Does this matter? Only if you frequently fire up demanding creative tasks, where you'll notice (for example) slower behaviour when scrubbing a video timeline. And don't forget that the built-in NPU not only enables Copilot+ PC features but other AI-based tools. There will be times where the AIO 9i Gen 10 is far faster at completing a task than the Gen 8.

BENCHMARKS



The biggest benefit comes in gaming thanks to the mobile RTX 4050. It doesn't set the world on fire, but can deliver smooth frame rates in modern games at 1080p with High settings. For instance, the Yoga averaged 70fps in *Shadow of the Tomb Raider* and 77fps in *Civilization VII*.

Even at lower resolutions games look fantastic on the beautiful 32in 4K IPS display, with its only visible downside being the 60Hz refresh rate. It covers all of the DCI-P3 space with an average Delta E of 0.24, while brightness peaks at a startling 572cd/m² in the centre; with HDR content, that jumps to 685cd/m². A glossy finish means you can see reflections in a well-lit environment, but I still prefer the punchiness this adds to images.

It's not the only nice thing to look at: Lenovo's design features a metal U-shaped chrome display stand that makes it seem like the screen is floating above the base. This is where the computer itself is housed, with the bonus of a wireless charger on top.

I question the positioning of the ports. They're all on the back of the base, making them tough to reach if you have a deep desk. You can't see the ports either, so you're constantly fumbling around trying to align your USB cable with the correct input: two USB-A and two USB-C ports sit alongside a 3.5mm combo jack and HDMI output. There's no wired Ethernet, but Wi-Fi 7 is on hand.

The built-in webcam delivers clear visuals with little noise, but I found it pointed too high, meaning my face was always in the lower half of the frame. I tilted the monitor down to its full extent (5°), but even then it wasn't ideal. There's no height adjustment here either. One nice touch, though: a physical kill switch for the camera on the base. The speakers also sound great, featuring two tweeters that fire from the base and two 5W subwoofers positioned behind the display.

"In day-to-day use, it's extremely powerful: if you need an all-in-one for office tasks, this won't break a sweat"

One last complaint: I wish Lenovo had built in a receiver for the bundled keyboard and mouse as HP does on its OmniStudio all-in-ones. Here, Lenovo supplies a USB-A receiver, taking one of only two USB slots. The keyboard is fine, but the mouse is made from cheap-feeling plastic and has a loud, irritating click.

It will be interesting to see how HP's upcoming OmniStudio X compares, but the Yoga AIO 9i is the best Windows AIO I've tested. Yes, I'd like to see ergonomic improvements, but the gorgeous design, speedy everyday performance and gaming skills lift it above the rest. **ZAC BOWDEN**

BELOW **The ports are awkwardly placed on the rear of the base**

SPECIFICATIONS

8-core (4 P-cores, 4 E-cores) Intel Core Ultra 7 258V processor • 6GB Nvidia GeForce RTX 4050 graphics • 32GB LPDDR5X-8533 RAM • 31.5in 60Hz IPS non-touch panel, 3,840 x 2,160 resolution • 1TB M.2 PCIe Gen4 SSD • Wi-Fi 7 • Bluetooth 5.4 • 1080p IR webcam • HDMI 2.1 output • Thunderbolt 4/USB-C 4 • USB-C 3.2 Gen 2 • 2 x USB-A 3.2 Gen 2 • 3.5mm combo jack • 2 x 5W speakers • Lenovo Ultraslim wireless keyboard and mouse • Windows 11 Home • 859 x 341 x 658mm (WDH) • 8.5kg • 1yr limited RTB warranty • part code F0HX0014UK

Acer Predator Orion 7000 (2025)

This high-end gaming PC is worth considering if the price is right – but it needs to duck under £3,000

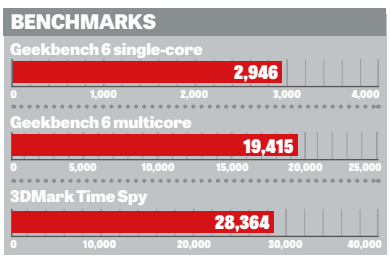
SCORE ★★★★☆

PRICE £2,749 (£3,299 inc VAT)
from currys.co.uk

This is the fourth PC I've tested with a GeForce RTX 5080 inside, but the first from a non-British PC manufacturer. It's also the first to choose a Core Ultra 7 265K processor as its partner, with others opting for either the Core Ultra 9 285K (*CyberPowerPC Infinity Z890 Elite, issue 367, p53*) or Ryzen 7 9800X3D (*Scan 3XS Edge iCue, issue 367, p50; Wired2Fire R7X3D RTX 5080 Beast, issue 367, p52*).

The Core Ultra 7 265K isn't a terrible choice: as the "K" indicates it's unlocked, so with the liquid cooler and a "CycloneX 360" triple-fan cooling system I suspect Acer has eked as much out of the chip as is possible. But so do Acer's rivals with their superior gaming chips, and that's probably the reason why the Predator Orion 7000 was always at the bottom of our gaming benchmarks.

This was by a small but consistent amount when gaming at 4K (and if you're paying this much, there's no point doing so at anything less than 4K). At *Cyberpunk 2077*'s default Ultra settings, it equalled the Scan with 89fps but fell behind 93fps for Wired2Fire and 94fps for CyberPowerPC. *Dirt 5* saw a bigger drop: 145fps for the Acer, while its rivals raced between 159fps and 163fps. *Shadow of the Tomb Raider*? At Highest settings, it averaged 202fps compared to 220fps to 224fps.



How much this matters is debatable. A 5% to 10% gap will rarely be the difference between playable and non-playable frame rates in your favourite game, and the Acer stays cool without stressing the fans. Arguably a small drop in frame rates is worth it in return for near silence.

This is one advantage of Acer having full design control over the airflow in the chassis, not to mention seven large fans to share the burden. You can ramp up the fan speed (and the noise) in Acer's PredatorSense software, but the results barely shifted so I'd stick with the automatic settings.

PredatorSense is also where you control the lighting effects across the multitude of fans, with a wide range of options (and even control over brightness). It's a much smoother app to use than most of its ilk, albeit a tad simplistic. With the fans on my chosen colour settings, I warmed to the brutalist design of the PC itself. Its main distinguishing feature is the front area that juts out by around an inch; this showcases three ARGB fans, complete with a Predator "mask" covering the top fan and stylish honeycomb metal pattern around the ridge edges.

ABOVE There's plenty of storage expansion, including two 3.5in hard disk bays

LEFT It's a typical chassis aside from the front area, which juts out over a inch

"The Acer stays cool without stressing the fans. Arguably a small drop in frame rates is worth it in return for near silence"

BELOW Acer's CycloneX 360 fans help to keep things cool and quiet

Unusually, you have to remove two screws to get inside the case, where you'll find an Acer motherboard based on Intel's top-end Z890 chipset. That means one of the three available M.2 storage slots supports Gen5 drives, although the supplied 2TB SSD is Gen4 – it's still fast, though, with 7,152MB/sec sequential reads and 6,529MB/sec writes. Want more storage? Two 3.5in hard disk caddies sit ready at the bottom of the chassis, and if you remove the right-hand side you'll discover two bays for 2.5in SSDs. You'll need to untangle the neatly bundled cables and wires, though.

Acer offers one more storage expansion option: an external caddy that slots into the top of the chassis. It ships empty, so you'll need to supply your own M.2 SSD, but doing so makes it easy to move your stored games with you if you change this as the default storage area for them. Aside from the two empty DDR5 sockets, offering a maximum of 128GB if you can find another home for the supplied pair, that's it for expansion, with no PCIe slots waiting for extra cards.

Fortunately, you don't need to worry about networking as Acer covers all the bases with a 2.5GbE wired connection and Wi-Fi 6E M.2 card, while there's a respectable helping of USB-C ports (one on the top and one Thunderbolt 4 at the back) and USB-A ports (three top, five back). Nor will the 1,200W power supply ever be troubled, with this system idling at around 70W and hitting a peak of 592W during our tests.

Despite forcing me to dust down my screwdriver, I enjoyed using the Predator Orion 7000 and I'm not overly concerned by it failing to match its RTX 5080 rivals for frame rates. My biggest question mark is over the price: £3,300 feels like £500 too much, so I'd wait for a promotion before pressing Buy. **TIM DANTON**

SPECIFICATIONS

20-core (8 P-cores, 12 E-cores) Intel Core Ultra 7 265K processor • Acer custom motherboard (Intel Z890 chipset) • 32GB DDR5-6000 RAM • 16GB Nvidia GeForce RTX 5080 graphics • Acer CycloneX 360 system fans (inc liquid cooling) • 2TB PCIe Gen4 SSD • Acer Predator Orion 7000 chassis • 1,200W Acer custom PSU • Windows 11 Home • 219 x 505 x 485mm (WDH) • 1yr RTB warranty • power consumption: 70W idle, 592W peak • part code: DG.E4DEK.003

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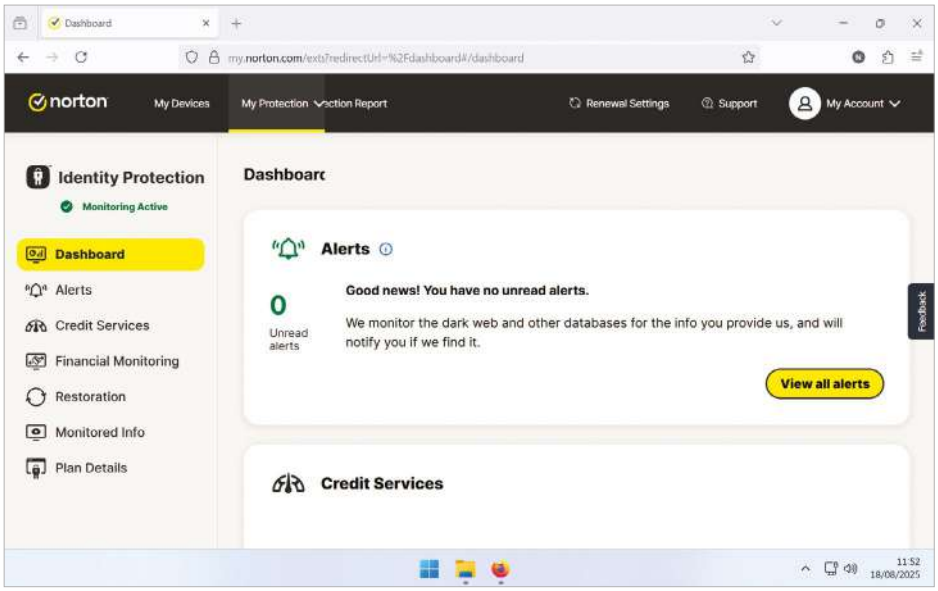
uk.norton.com
REQUIRES Windows 7 or later; iOS 13 or later; Android 8 or later; online registration

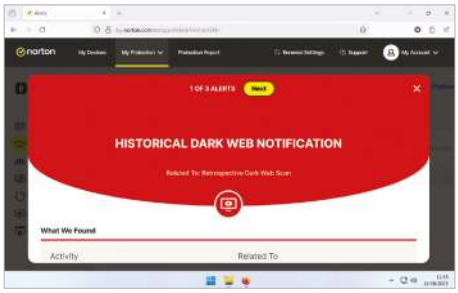


With so many aspects of modern life now conducted online, there's an ever-increasing risk that your personal information could fall into the wrong hands – and when it does, it can easily be misused. Your bank details, phone number or other information could be exposed as part of a leak or a targeted attack, the consequences of which can be disruptive and costly.

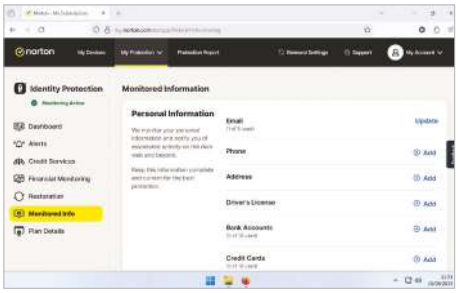
This is what Norton Identity Advisor Plus helps you avoid. Simply tell Norton what information you want to protect and the service will then continually monitor online forums, the dark web and more to check whether it's been exposed. If anything concerning is spotted, you'll be notified right away, so you can take steps to protect yourself, such as cancelling bank cards or getting in touch with financial institutions to warn them about suspicious activity. The sooner you do this, the better your chances of preventing thieves from abusing your information – which makes Identity Advisor's active alerts hugely valuable.

While there are obvious implications to having your bank details stolen or leaked, that's not the only sort of data breach you need to worry about. The dangers of having other types of data falling into malicious hands may not be immediately obvious, but if an attacker can collect information such as your phone number, email address, previous address, mother's maiden name and so on, they could use it to fraudulently open accounts in your name – or carry out a phishing attack to trick you into giving up further information. It's easy to be fooled by someone claiming to be your bank when they're armed with personal information that shouldn't be easily obtained. And in addition to monitoring the dark web and regular internet for your personal data, Norton will also keep an eye on your social media accounts and financial transactions for signs of suspicious activity.

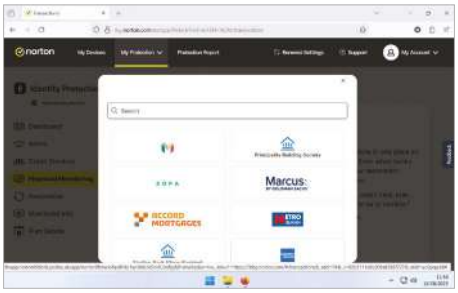
Norton Identity Advisor Plus is a service rather than a piece of software, so you don't need to install anything to use it – you can access the online dashboard from any web browser, or install the free mobile app for iOS and Android. This gives you all the same information in a format that's tailored for the smaller screen, for easy peace of mind even when you're out and about.



ABOVE Identify Advisor has found our email address on the dark web; scrolling down gives more information



ABOVE The more information you provide, the more variables Identity Advisor will be able to use when searching the web for your exploited data



ABOVE You can use the financial monitoring tools to keep an eye on transactions passing through your bank accounts

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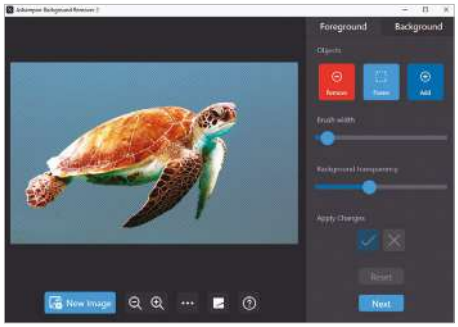

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REQUIRES Windows 10 or later; 100MB drive space; in-app registration

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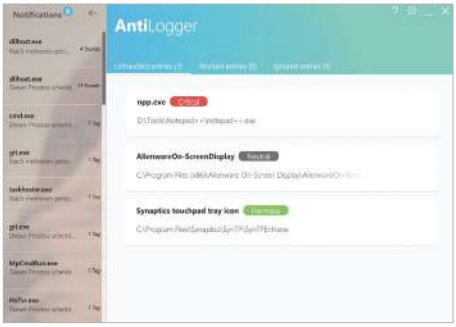
- Report screen lists all programs that could potentially be monitoring your keyboard input



Full product worth £10 abelssoft.net
REQUIRES Windows 10 or later; 50MB drive space; in-app registration

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Full product worth £20 audials.com
REQUIRES Windows 10 or later; 1GB drive space; in-app registration

- One-stop shop for all your streaming media needs, from music and podcasts to TV and radio
- Search for songs and One scours the web for them; download tracks to enjoy later
- Access thousands of online radio stations

IObit Smart Defrag 11

Six-month licence worth £10 iobit.com
REQUIRES Windows 7 or later; 50MB drive space; online registration

- Defragment and compact the contents of your drive to optimise your PC's performance
- Deep optimise mode reorganises the files on your hard drive for best possible speeds
- Defrag on demand, or run when your PC is idle

Laplink PCmover Express 11

Full product worth £25 laplink.com
REQUIRES Windows 7 or later; 250MB drive space; online registration

- Migrate your files, settings and other data from one PC to another, without manual intervention
- Scans your old system to calculate what to transfer and how long it will take
- Can transfer over Wi-Fi – no cable required

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Canon Maxify GX7150

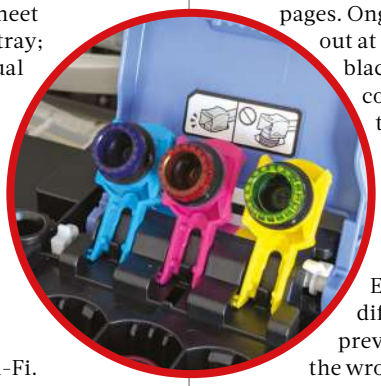
Refillable, flexible and thoroughly likeable – but it's only good value if you print a huge volume

SCORE ★★★★☆

PRICE £528 (£634 inc VAT) from canon.co.uk

We love a refillable inkjet. Farewell stingy cartridges, high running costs and wasted plastic; hello simple, cheap bottles of ink and extended service intervals. Canon's Maxify range is geared towards home power users and busy small offices, and the GX7150 its new range-topping refillable multifunction peripheral (MFP).

This is a four-in-one, combining print, scan, copy and fax. On top, an automatic document feeder (ADF) juggles up to 50 sheets of paper; behind it sits a 100-sheet multipurpose paper tray; and the base holds dual 250-sheet paper cassettes. Both the printer and ADF support duplex operation, making double-sided prints, scans, copies and faxes a reality.



You can connect this printer via USB, wired Ethernet or Wi-Fi. Everything is controlled by the 2.7in tiltable colour touchscreen and a smattering of dedicated buttons. The only omissions are a USB host port for walkup scans and prints, and SME-grade options such as extended trays, staplers or NFC readers.

The GX7150 arrives with enough ink to print around 6,000 black or 14,000 colour pages. Dividing its purchase price by 6,000 gives you a cost per page of around 7.3p (8.8p inc VAT), on a par with competing cartridge-based inkjets – and at that point you'd still have enough colour ink left for around 8,000 further pages. Ongoing refills work out at only 0.2p per black page and 0.4p in colour – roughly a tenth the cost of a conventional inkjet.

Setup is simply a case of removing some tape and filling up the tanks. Each bottle has a different opening to prevent you fitting it to the wrong tank; you simply invert the bottle and push it gently onto the spigot, then wait while gravity empties it into the tank.

Aside from a few minutes' delay while the printer primes itself, setup is free of frustrations. Canon's mobile software is simple to use and covers the main print and scan features. The full PC driver suite includes a TWAIN scan interface that offers a great balance of usability and features.

ABOVE The Maxify GX7150 produces good-quality prints

LEFT The refillable ink tanks mean running costs are low if you print large volumes

"If you'll get through the bundled ink – and particularly if you expect to print much more – the GX7150 should prove exceptional value"

LEFT A 2.7in colour touchscreen makes it easy to control

The touchscreen makes direct functions easy to control, but it's a shame there isn't a single menu option for duplex photocopying; instead, you have to select duplex scanning and duplex printing separately. The screen provides helpful information such as the number of pages left to print during a multi-page job. This indication is for pages, not sides, however, so duplex jobs have further to go than you might at first realise.

During our duplex copy test, the first tray ran out of paper. The GX7150 seamlessly switched to tray two mid-job. Not only that, it allowed us to refill the first tray, all without interrupting the ongoing printing. This MFP doesn't support multitasking, though, so we couldn't start a scan job while the printer was busy on another task.

It's rapid when printing text, taking 13 seconds to produce a first page, then hitting 20.8 pages per minute (ppm) in our 25-page mono letter test. Switching to Economy print quality was no faster, but it didn't result in obviously inferior text quality – worth noting, as Canon says you'll get 50% more pages from your ink that way.

We were less impressed with its colour print speeds. Our test document is a challenging, graphics-rich collection of presentation slides and magazine pages, but given the GX7150's fast text prints its 5.7ppm here was underwhelming. We test duplex printing by repeating the first ten pages of this document, again in colour. The GX7150 paused mid-job for housekeeping – likely ink priming or head cleaning – resulting in a lowly 3.1 images per minute .

This isn't a photo printer and it doesn't support borderless printing, even on 6 x 4in photo paper. Its pigment inks aren't ideal for glossy photo papers, on which they dry to a semi-gloss finish rather than a fully glossy shine. Still, it's quite quick, managing two 10 x 8in prints in three-and-a-half minutes.

Our photocopy tests underlined the difference in speed between black and colour work. The Maxify GX7150 could copy an A4 page in black in only 11 seconds. Using the ADF it copied ten pages in 52 seconds. Switching to colour, the same tests took 14 seconds and 101 seconds respectively . This printer can make duplex copies, with

its impressive ADF capturing both sides of a double-sided original in a single pass, rather than mechanically flipping the page over. Even so, a 20-sided (ten-page) colour copy needed seven minutes; we've seen much faster results than this.

Happily, network scan speeds were good. This MFP completed a preview scan in seven seconds, and could capture an A4 document at 150 dots per inch (dpi) in 13 seconds. The same job took 21 seconds at a middling 300dpi resolution. Capturing a 6 x 4in photo at 600dpi also took 21 seconds.

The Maxify GX7150 isn't tailored towards creative uses such as photo printing and scanning, but it's not a bad performer. We mentioned photo prints' semi-gloss finish and white borders; they're otherwise fine for occasional use. Photo scans, on the other hand, were excellent, with exemplary colour accuracy and extremely impressive focus – at 100% zoom we could make out individual dots in scanned inkjet photos.

The Canon Maxify GX7150 is tailored for office use, however, and here it really delivers the goods. Text prints are as sharp and dark as you'll get from an inkjet, while colour graphics are excellent. While many inkjets use less ink when duplexing to avoid smears and bleed-through, the GX7150 favours longer drying pauses. That's a slower approach, but the exceptional quality of our duplex prints showed its value.

While photocopies were perhaps half a stop darker than ideal, losing detail from dark regions of the page, they were better than average in black or colour. Finally, the scanner faithfully captured office documents, producing legible text and reproducing images well.

We'd forgive you for baulking at the steep asking price for this MFP. It's a lot of money, and frankly, not worth it if you're unlikely to print more than a few hundred pages a year. However, if you'll get through the bundled ink – and particularly if you expect to print much more – the Canon Maxify GX7150 should prove exceptional value, with ongoing running costs of well under a penny per page. Add in the protection of a three-year warranty, and you can be confident you'll probably have time to recoup the investment. **SIMON HANDBY**

SPECIFICATIONS

Four-colour 600 x 1,200dpi A4 inkjet MFP • refillable ink tanks • 1,200dpi colour flatbed A4 scanner • 2.7in colour touchscreen • Wi-Fi 5 • USB-B • 10/100 Ethernet • 33.6K fax modem • automatic duplex printing • 2 x 250-sheet A4 cassettes • 100-sheet rear tray • 399 x 410 x 314mm (WDH) • 13.1kg • 3yr on-site exchange warranty

Dell Pro 32 Plus QHD USB-C Hub Monitor (P3225DE)

A solid-value 32in monitor geared towards hybrid workers and office rollouts thanks to its superb hub

SCORE ★★★★☆

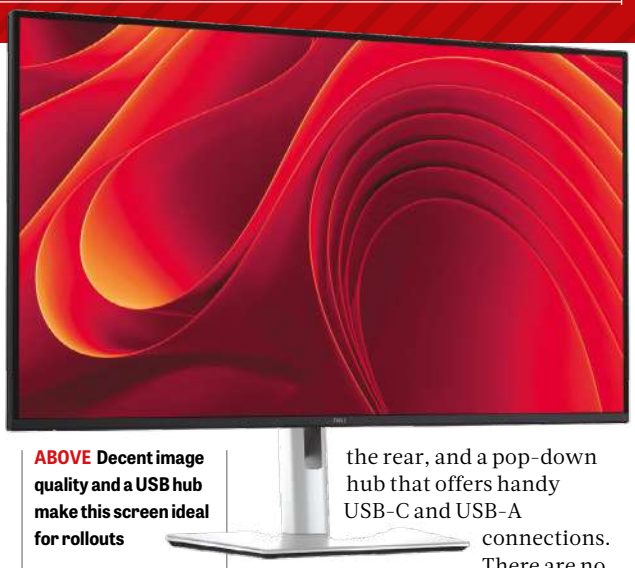
PRICE £337 (£404 inc VAT) from dell.co.uk

Once you understand Dell's way of thinking, it's easy to navigate its monitor range. The "Pro" indicates this is a business-targeted product, the "Plus" that quality will be good but not great. Within its Dell Pro Plus monitor range, you can easily jump between sizes (14in up to 55in), and if you select the 32in version as here then you have the choice of a QHD (2,560 x 1,440) or UHD (3,840 x 2,160) panel.

Choosing the latter increases the price to £550 inc VAT, and you'll definitely notice the sharper image if you do. It increases the dpi from 93 to 140, and in daily use I noticed a lack of sharpness around text. In terms of productivity, I found it pushed me towards working with two windows side by side rather than having three in view – hardly a disaster, but I was glad to return to a 4K 32in monitor.

It isn't the most colourful of panels, tuned to the conservative sRGB space rather than impactful DCI-P3. That makes sense for office rollouts, but if you're looking for a screen that can double up for games and films after hours then you'll be disappointed. Still, within its colour range this is a high-quality panel, with excellent colour accuracy, and – if you push the brightness towards its 342cd/m² peak – whites look good, too.

Where Dell wins is ease of use. Not only do you benefit from its excellent Display and Peripheral Manager software, which gives control over settings when connected over USB-C, but there's a built-in network port, two USB-A ports at the rear, and a pop-down hub that offers handy USB-C and USB-A connections. There are no speakers or webcam, though.



ABOVE Decent image quality and a USB hub make this screen ideal for rollouts

Alongside an HDMI and DisplayPort input, Dell provides a DisplayPort output so that you can daisy-chain a second monitor. With slim bezels on every side, plus the ability to pivot, this could lead to an interesting setup. Extra flexibility comes from 150mm of height adjustment, although neither the 30° of swivel or tilt (5° down, 21° up) are impressive. This is a well-put together monitor, however, so there's no annoying wobble to put up with.

"Within its colour range this is a high-quality panel, with excellent colour accuracy, and whites look good, too"

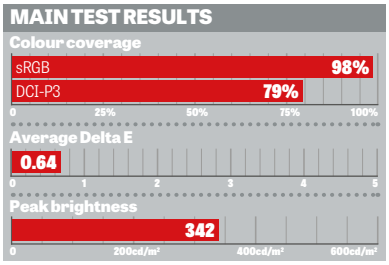
Dell also puts thought into the OSD, controllable via an effective mini joystick mounted at the rear right. Things are simplified by a lack of options – this is a basic office monitor at its heart – but you can take control of the quick options that appear if you press down on the joystick. For instance, put Preset Modes into a slot if you frequently jump between Standard, Move, Game, Warm, Cool and Custom Colour presets, or Input Source if you often switch between computers.

BELOW The sturdy stand means the display won't wobble on your desk

Finally, it's great to see EPEAT Gold with Climate+ and TCO 10 certification. The challenge for Dell is that others beat it for value, particularly the 34in curved Iiyama ProLite XCB3497WQSNPH (*see issue 372, p93*) which costs £380 inc VAT but has a sharper 3,440 x 1,440 resolution (110ppi), a similar feature set and a more colourful panel. **TIM DANTON**

SPECIFICATIONS

31.5in 2,560 x 1,440 IPS panel • up to 100Hz refresh rate • 10-bit panel (1.07 billion colours) • 5ms grey-to-grey response time • USB-C (90W) • HDMI 2.1 • DisplayPort 1.4 • DisplayPort out • 1GbE RJ45 • USB-C 3.2 Gen 1 (15W) • 3 x USB-A 3.2 Gen 1 • 150mm height adjustment • -5° to 21° tilt • 30° swivel (left/right) • pivot • 713 x 215 x 469-619mm (WDH) • 9.5kg; EPEAT Gold • 3yr advanced exchange warranty



All measurements in default profile

Xreal One Pro

The high price remains an obstacle, but the OLED panel and spatial computing tech lend it appeal

SCORE ★★★★☆

PRICE £483 (£579 inc VAT)
from xreal.com

The original Xreal One AR glasses impressed us back at the start of the year (*see issue 366, p70*), and I've been eagerly waiting to try out the enhanced Pro version. Now it's finally here, I'm delighted to say it's worth the wait; it might even be worth the steep asking price.

If you're not familiar with AR glasses, the idea is simple: using a standard USB-C cable, you can connect them to almost any smartphone, laptop or computer, and either extend or duplicate the device's display onto the inside of the lenses. The result is a huge, high-quality virtual screen that's completely private to you. I love this technology for long trips on trains and planes, as it allows me to turn the phone in my pocket into a personal movie projector – but no matter where you wear them, AR glasses open up a whole new world of entertainment and productivity.

The Xreal One Pros look similar to the original Xreal Ones, but the front is much flatter, with a sleek and subtle design. AR glasses are usually bulky, conspicuous things – on long-haul flights, I'm accustomed to getting double-takes when I'm wearing my larger-than-life techno specs, but nobody has yet batted an eye at the Xreal One Pros – and while they're slightly heavier than the regular Ones, their premium construction feels great to wear for hours.

The other big difference becomes obvious once you put them on. Thanks to a new Sony micro-OLED display, the Xreal One Pro really showcases the visual capabilities of the company's custom-designed X1 processor. It's the best picture quality I've seen from any AR hardware, with supreme clarity and colour.

As a bonus, the image is also noticeably bigger than you'll get with the regular Xreal Ones. Where those have a 50-degree field of vision, the Pros extend this to 57 degrees, giving you the equivalent of a 171in ultrawide (32:9) display, viewed from four metres away, with the resolution of two 1080p displays side by side. To be sure, that's nowhere near the best in the business – the Meta Quest 3 goes up to a terrifically immersive 110 degrees – but in use I found myself perfectly happy with the scale and stability of the virtual screen.

On that note, the X1 chip provides three-axis head tracking while you're wearing the glasses, so if you activate anchor mode, the display stays put wherever you've pinned it in virtual space, while you can freely look up, down and all around it. Alternatively, you can switch to follow mode, where the display is always central in your vision, or temporarily shunt the display up into the top corner, to keep it in view while interacting with the world around you.

No matter which mode I tried, I never saw any sign of fringing or edge blur, and the electrochromic lenses do a great job of shutting out unwanted intrusions from the outside world: you can adjust these from fully blacked-out theatre mode to clear mode, or pick a restful shade in between. Throw in a 120Hz refresh rate for perfectly smooth tracking and on-screen action, and it's an amazing experience for games, movies or work. If you're not worried about disturbing the person next to you, you can even enjoy surprisingly powerful sound from the tiny Bose speakers built into the arms.

The glasses come with very little in the way of accessories – just a cable, a set of nose pads and a protective case – but you can optionally add on the £99 Xreal Eye camera, which clips onto the front of the nose bridge. This lets you capture 12MP stills and 1080p video from a first-person perspective while you're using the glasses; it's a fun idea, and it can produce some good-looking images, but it struggles in low light. The camera also increases the motion sensitivity to six degrees of freedom, tracking lateral movement as well as rotation, but I didn't notice that this had much effect.

ABOVE **The Sony micro-OLED displays provide superb clarity and colour**

ABOVE **A sleek design means the One Pros could almost pass for regular glasses**

In theory this technology should open up the next upgrade to Xreal's spatial computing experience, but since that's not here yet I'd recommend you save the money for now.

Although the Xreal One Pro glasses are extremely impressive, the price is hard to justify. For anyone just wanting a handy personal display for their Steam Deck, or an expansive movie experience in a confined space – which is probably most potential buyers, to be honest – the Xreal One will do a fine job for £130 less. Indeed, there are decent options at far cheaper prices, such as the RayNeo Air 3s (*see issue 369, p73*), currently available on import for around £220 inc VAT.

"The Xreal One Pro glasses represent a generational leap forward in display technology, and in the AR user experience"

But the Xreal One Pro glasses aren't really aimed at that market: they represent a generational leap forward in display technology, and in the AR user experience. If you're someone who's regularly on the go and demands a premium display to use in place of a laptop screen or portable monitor, the One Pro is an unbeatable investment that should keep you happy for a very long time. **JASON ENGLAND**

SPECIFICATIONS

Xreal X1 Chip with Optic Engine 4 • 2 x 0.55in 1,920 x 1,080 120Hz micro-OLED displays • 700cd/m² perceived brightness • 57° field of view • 152in virtual display at 3m • 3 DoF • 2 x open-ear speakers • USB-C • 160 x 147 x 48mm (WDH) • 87g • OS independent • 1yr warranty

LEFT **Tiny Bose speakers in the arms provide surprisingly powerful audio**

Viture Luma Pro

Impressive clarity and mesmerising colour packed into a sleek pair of specs, but beware the import costs

PC PRO RECOMMENDED

SCORE ★★★★☆

PRICE $499 (plus $25 delivery and duty costs) **from** viture.com

ABOVE **The stylish Luma Pro provides stunning visuals**

When it comes to choosing a pair of AR glasses, wearability, picture quality and versatility all come into play – and Viture's latest specs excel in all three regards. It's true that Xreal has a technical advantage with the X1 chip built directly into its One Pro glasses (*see opposite*), but if you're looking for a comfortable viewing experience with great picture quality, the Luma Pro is absolutely worth considering.

In the US, the Luma Pro costs $499, the same as the standard Xreal One glasses. However, Viture doesn't have a UK distributor, so while you can order these glasses online, you'll need to pay for international shipping plus VAT and import fees, which together push the price close to £500.

Even at that price, the Luma Pro is a very likeable piece of kit. The frames are comfortable and stylish, and the display is stunning. To understand what makes it so special, I need to tell you about the technology behind the Viture Luma Pro. It starts with Sony's micro-OLED display; this is a little more power-efficient than previous AR displays, so you'll get more battery life out of whichever device you plug these into.

A bigger deal is the custom tweaks Viture has applied to make the image look a lot sharper than its 1200p resolution would imply; the firm refers to it as "4K-like". This is achieved using telescope-inspired optics to minimise distortion, with a camera-grade anti-reflective coating has also been applied to eliminate glare.

The result is a gloriously crisp picture, with vivid colour and an equivalent screen size of 152in that makes games and movies look spectacular. The sharp display makes these glasses unusually good for text-based productivity applications, too, for those who want to work on the big screen. There's a very welcome myopia adjustment, although, to avoid distortion, the glasses can only compensate up to -4 dioptres, so those with stronger prescriptions might not be able to take advantage.

The design of the frames is just as thoughtful. The familiar faux-Wayfarer design is getting more and more subtle by the generation. You still wouldn't mistake these for regular shades, with their big "birdbath" optical units sitting behind the lenses, but slight refinements in the size and shape take us another small step towards a truly stylish design. I even rather enjoy the customisable lighting effects along the arms: normally, I find RGB pretty cringe, but this is so tastefully done I can't help but appreciate it.

It's not all about looks, though: Viture has clearly thought about practicalities and ergonomics. Three sets of magnetic nose pads are supplied in the box, so you can easily snap on the ones that set the glasses at the best height for your eyes, and the arms can be set at different angles for just the right wearability. The soft-touch plastic that sits over the ears makes these impressively comfortable over many hours of wearing, on long flights or through a whole day at work.

LEFT **The design of the glasses is thoughtful and practical**

Inevitably, there are weaknesses. For one – as is pretty inevitable with AR glasses – the audio is lacking. The Harman-branded sound system may suggest an audiophile experience, but at the end of the day any speakers that come built into a pair of glasses are going to be tiny. At maximum volume the sound is easily drowned out by background noise – and when you're somewhere quiet enough to properly hear them, they're pretty tinny. You'll want to pair some decent headphones to properly enjoy games and movies.

"The Luma Pro is a very likeable piece of kit. The frames are comfortable and stylish, and the display is stunning"

The other big issue is to do with the software. Unlike Xreal, which relies a lot on its home-grown X1 silicon, Viture likes to implement its features in software. This might mean missing out on certain optimisations, but it gives you a lot more flexibility, and the Luma Pro offers some tricks that the Xreal glasses simply can't match, such as simulating a triple-stacked vertical display array, or turning 2D content into 3D. I'm impressed by how well these features work, and I also like the way you can place a virtual screen in mid-air next to a physical desktop monitor or laptop display to seamlessly extend your workspace.

The catch is that not all the Luma Pro's promised features are up and running just yet. For example, the glasses have a built-in camera that can be used both for taking photos and for six-degrees-of-freedom motion tracking, so that virtual windows can be locked to any location in space. That's the idea, anyway – but those features aren't yet enabled, so who knows how well they'll work?

Yet despite those question marks, the Viture Luma Pro specs are among the best AR glasses you can buy. The Xreal One Pro glasses offer a bigger screen, a wider field of vision and an anchor mode that works really well, but the Luma Pros are cheaper, even with import costs – especially since the camera is built in. Just going by the software capabilities that are working already, it's an admirably versatile partner for a spatial computing world, and the picture quality is superb, no matter what device you plug them into. **JASON ENGLAND**

ABOVE **Adjustable arms and a selection of nose pads make the glasses comfortable to wear for long periods**

SPECIFICATIONS

On-device chip not specified • 2 x 0.55in 1,920 x 1,200 120Hz micro-OLED displays • 1,000cd/m² perceived brightness • 52° field of view • 152in virtual display at 3m • 3 DoF • 2 x open-ear speakers • USB-C • large, 172 x 147 x 46mm (WDH) • 81g • OS independent • 1yr warranty

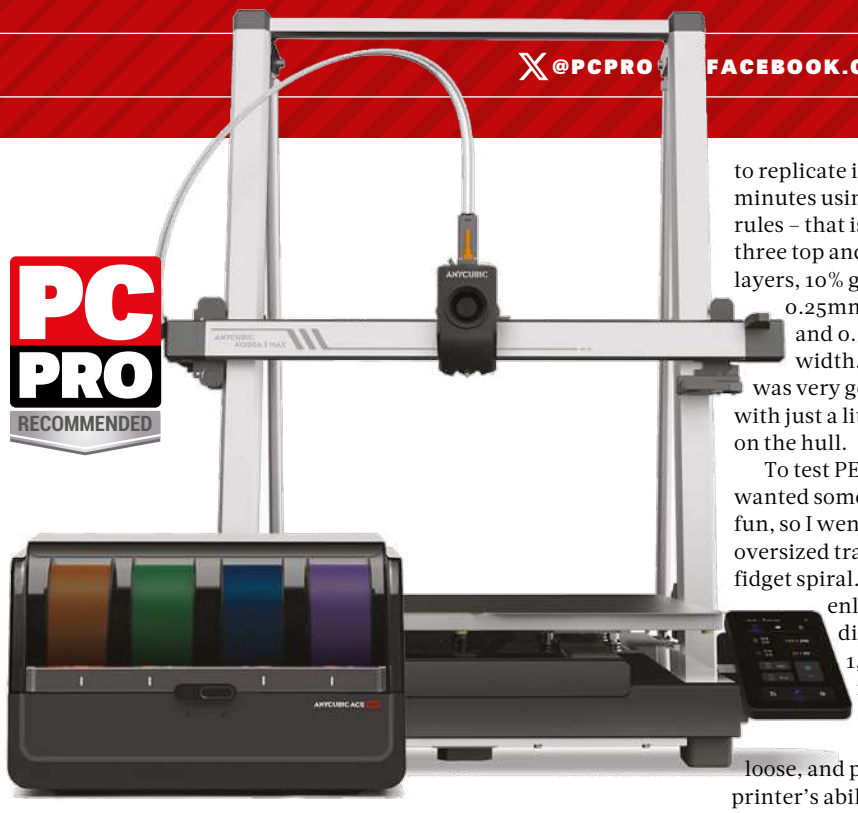
Anycubic Kobra 3 Max Combo

A super-sized 3D printer with a four-colour spool system that delivers on both quality and speed

PC PRO RECOMMENDED

SCORE ★★★★★

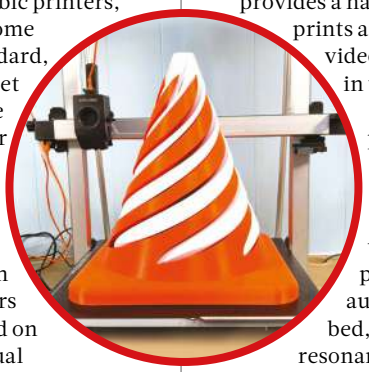
PRICE £458 (£550 inc VAT) **from** uk.anycubic.com



The Anycubic Kobra 3 Max Combo is one of the biggest multicolour personal 3D printers on the market. It can turn out huge models using up to eight different filaments, and the user experience and overall print quality are both excellent.

The package comes with everything you need to get started, including a USB flash drive containing the documentation and a small sample of PLA. It also comes with a guide to assembling the printer, along with the necessary tools. This isn't a difficult job – you mostly just need to slot the pieces together and screw them into place. You also need to install the supplied four-colour filament hub, although if you're happy with mono printing you can get the single-colour version for £200 less.

Once it's all set up, the assembly has the same modern look as other Anycubic printers, with a sleek aluminium finish and orange accents. Also like other Anycubic printers, however, it doesn't come with a camera as standard, so you'll need to budget £15 for the official one if you want to monitor your prints from afar.



Although it may not be obvious at first, the printer has plenty of clever design features. Dual Z motors have become standard on larger printers, but dual Y-axis motors for the bed are unusual – and most welcome for large, hefty prints. The nozzle has a quick-release lever, so you can slide it out without having to unplug other components, and the toolhead cutter can also be removed, to expose the usual point of extruder clogging. This made it very quick and easy to clear out the one clog I experienced in over 600 hours of print time.

I like the 4.3in colour touchscreen, too, which is bright and responsive with intuitive controls. My only gripe is that, when you're loading up a new filament, the interface offers a very limited range of colours to assign to it.

On the desktop side, the printer comes with a copy of Anycubic Slicer Next. This is nearly identical to Bambu Studio or Orca Slicer, so if you're familiar with 3D printer software you'll be right at home. As well as managing your prints from here, you can decide what to do with the filament that's wasted when swapping colours, choosing whether to purge it into the infill, or into a separate object.

There's a mobile app too, but I didn't personally find this very useful. Beginners may enjoy being able to send files directly to the printer from Anycubic's Maker Online website, but I prefer to use my PC. Still, the app provides a handy way to monitor prints and create time-lapse videos, if you've invested in the camera.

With a maximum print size of 42 x 42 x 50cm, you can create some very sizeable items. At the start of each print you can automatically level the bed, perform a quick resonance-compensation routine, enable dynamic flow compensation and turn on the filament dryer while printing. There's really nothing that you need to calibrate by hand, although I did find that the build plate wasn't 100% reliable for prints taking more than 12 hours; I solved this by slathering it in glue, but it would be good to have a sticky build plate option.

I started off my testing with a normal-sized Benchy in PLA. The printer comes with an 18-minute Benchy test print, but I was only able to replicate it at around 28 minutes using speedboat rules – that is, two walls, three top and bottom layers, 10% grid infill, a 0.25mm layer height, and 0.5mm layer width. The quality was very good, however, with just a little roughness on the hull.

To test PETG printing, I wanted something big and fun, so I went for an oversized traffic-cone fidget spiral. This meant enlarging the digital model by 1,200%, which made the tolerances extremely loose, and pushed the printer's ability to bridge to the limits – but it ended up doing a brilliant job, with a lovely smooth finish and just one small layer line from when I ran out of filament and took too long to find a second spool. Printing the orange and white parts individually, the complete model took about three days in total to print.

I mentioned that the Kobra 3 Max can print in up to eight colours, but this requires a second four-colour filament unit. You can order one from Anycubic, or you can actually print the part you need, and just feed four additional filament tubes into the toolhead. I tried it out with a detailed steampunk dragon model; the results were impressive, but the whole print took 48 hours and more than 900 filament swaps.

ABOVE **The Kobra 3 Max is an impressive multicolour 3D printer**

"It can turn out huge models using up to eight different filaments, and the user experience and print quality are both excellent"

LEFT **PETG printed models such as this oversized traffic cone emerge smoothly**

Despite its size, the Kobra 3 Max is reasonably quiet, putting out around 60dB in standard mode. If you need to keep the noise down, you can switch to "quiet mode", which runs the machine more slowly – but frankly I didn't see the need to try that.

Overall the Anycubic Kobra 3 Max Combo is an impressive printer in more ways than one. For those who don't need the multicolour features, the Elegoo Neptune 3 Max is a good single-colour alternative, and quite a steal at £380 – but if you want to print big models with a pop of colour, this machine is an excellent choice. **DENISE BERTACCHI**

SPECIFICATIONS

Fused deposition modelling (FDM) print technology • 0.4mm nozzle diameter • four colours • up to 600mm/sec print speed • dual Z-axis and Y-axis motors • 420 x 420 x 500mm build area • supports PLA, TPU, PETG materials • Anycubic Slicer Next software • 706 x 640 x 753mm (WDH) • 19kg • 1yr limited warranty

palicomp

01270 898 104
sales@palicomp.co.uk

pro-series

mid [PRO1]

£449.99

CPU	AMD RYZEN 5 8500G
Core	6 Cores - 12 Threads
Clock	(3.5/5Ghz Turbo)
Mob	ASUS TUF A620M-PLUS WIFI
RAM	ADATA 16GB DDR5 5600Mhz
M.2	TRANSCEND 1TB M.2 nVME
GPU	AMD RADEON Graphics
Case	KOLINK Observatory HF MESH
O/S	*NO OPERATING SYSTEM*
PSU	BUILDER 500W PSU

Max [PRO2]

£979.99

CPU	AMD RYZEN 5 7600X
Core	6 Cores - 12 Threads
Clock	(4.7/5.3Ghz Turbo)
Mob	ASUS PRIME B650M-A WIFI II
RAM	ADATA 32GB DDR5 5600Mhz
M.2	TRANSCEND 1TB M.2 nVME
GPU	NVIDIA RTX4060 TI 16GB
Case	1stPlayer D3-A aRGB - Black
O/S	*NO OPERATING SYSTEM*
PSU	CIT 700W PSU

UBER [PRO3]

£1159.99

CPU	INTEL Core i5 14600K
Core	14 Cores - 20 Threads
Clock	(2.6/5.3Ghz Turbo)
Mob	ASUS B760M-K
RAM	ADATA 32GB DDR5 5600Mhz
M.2	ADATA 2TB S70 Blade M.2 nVME
GPU	NVIDIA RTX4060 TI 16GB
Case	GAMEMAX F15M MESH
O/S	*NO OPERATING SYSTEM*
PSU	BEQUIET 850W Gold PSU

Aurora RANGE

i3 Aurora [AUR1]

£629.99

CPU	INTEL Core i3 14100F
Core	4 Cores - 8 Threads
Clock	(3.5/4.7GHz)
Mob	ASUS B760M-K
RAM	ADATA 16GB DDR5 5600Mhz
M.2	TRANSCEND 1TB M.2 nVME
GPU	NVIDIA RTX3050 8GB
Case	GAMEMAX Abyss Mini RGB
O/S	MICROSOFT Windows 10/11
PSU	CIT 600W Bronze PSU

i5 Aurora [AUR2]

£999.99

CPU	INTEL i5 14400F
Core	10 Cores - 16 Threads
Clock	(Turbo 4.7Ghz)
Mob	ASUS B760M-K
RAM	CORSAIR 32GB DDR5 6000Mhz
M.2	ADATA 2TB M.2 NVMe
GPU	NVIDIA RTX4060 8GB
Case	CORSAIR iCUE 4000X
O/S	MICROSOFT Windows 10/11
PSU	CORSAIR 650W PSU

i7 Aurora [AUR3]

£1599.99

CPU	INTEL Core i7 14700KF
Core	20 Cores - 28 Threads
Clock	(3.4/5.6Ghz Turbo)
Mob	ASUS PRIME Z790-P WIFI - DDR5
RAM	CORSAIR 32GB DDR5 6000Mhz
M.2	ADATA 1TB S70 Blade M.2 nVME
GPU	NVIDIA RTX4070 12GB
Case	CORSAIR iCUE 4000X RGB
O/S	MICROSOFT Windows 10/11
PSU	CORSAIR 650W Gold PSU

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Samsung Galaxy Watch8 & Galaxy Watch8 Classic

A big upgrade over the Watch7 series thanks to the built-in Gemini AI assistant, but the Classic stands out

SCORE ★★★★☆

PRICE Galaxy Watch8 from £266 (£319 inc VAT); Watch8 Classic from £374 (£449 inc VAT) **from samsung.com**

We've tested nearly every Galaxy Watch since the original, and each one has looked and felt a lot like the last. The Galaxy Watch8, however, brings two innovations: it's the first smartwatch to come with Google's Gemini AI assistant built in. And there's now a Classic variant that looks like a high-end mechanical timepiece with a 46mm face, a rotating bezel and a recessed "quick button" that resembles a regular crown – albeit for a premium £449.

If that's too steep, the regular Watch8 starts at £319 with a 40mm face, or £349 for the 44mm version. Both models have a clean, plain design, although the chunky metal surround makes them look oversized. While the Classic is better proportioned, its thick, stainless-steel construction is bulkier, which is especially noticeable when you wear it to bed for sleep tracking.

The colour options are distinctly conservative – silver or graphite for the regular model, black or white for the Classic – but you can personalise your look with a range of bands using Samsung's new "Dynamic Lug System". This promises a better fit than the Galaxy Watch7, for improved comfort and more accurate heart-rate tracking. Personally, I didn't notice any improvement over last year's model – and the new fitting means that old straps won't fit the new watch.

The screen is gloriously bright whichever model you choose, maxing out at 3,000cd/m². That's the same as the Apple Watch Ultra 2, and it gives you excellent readability, even when jogging in the sun.

Interacting with the watch is easy. The side buttons offer a satisfying tactile response, and the rotating bezel on the Classic lets you navigate without touching the display, which is not only less fiddly but keeps the screen fingerprint-free. The quick button, inherited from the Galaxy Watch Ultra, can be set to launch a small selection of apps, including the workout app, stopwatch, camera controller and voice recorder.

You can also talk directly to the built-in Gemini AI assistant. As long as the Watch8 is connected to your phone (or directly to the internet via its own 4G SIM, if you choose that option), it will give somewhat intelligent responses to your questions through the tiny internal speaker. It works nicely for everyday tasks such as navigating to nearby locations or checking your calendar, but it can't handle personal, contextual questions such as "should I go for a bike ride tomorrow?"

Despite their different looks, the Watch8 and the Watch8 Classic offer the same health and fitness features. There's a lot here, including the ability to automatically detect when you're walking, running, cycling, swimming or using gym equipment such as rowing machines and elliptical trainers.

On top of this, the Watch8 now features a personalised running coach. Though other wearables have had this ability for a while, it's new to Samsung – and even as a non-runner I found it quite inspiring. Once you tell it a few personal details, it gauges your ability based on a trial run, and builds a tailored plan to help you train and grow your fitness.

Sleep tracking is another strong suit for Samsung. The Galaxy Watch8 records whether you snored, moved around too much, experienced apnoea or got enough quality sleep to begin with – and presents the information in a detailed, actionable report. New in the Galaxy Watch8, you can also get bedtime guidance, which analyses your vital signs to determine your ideal bedtime window, and alerts you as it approaches.

ABOVE **The Galaxy Watch8 Classic looks like a traditional high-end timepiece**

Another new addition is vascular load tracking. This measures your heart strain during sleep over three nights to establish a baseline, and then tells you whether your lifestyle is reducing your heart efficiency or increasing it. For example, if you take on two epic workouts two days in a row, the watch may recommend you rest for a day before hitting the gym again.

As for battery life, Samsung says you can expect roughly 30 hours of use per charge with always-on display mode enabled, or 40 hours with it turned off. In our testing, the standard Galaxy Watch8 matched those expectations, while the larger Galaxy Watch8 Classic actually did rather better, lasting around 40 hours with the always-on display, and over 50 hours with it turned off. That's pretty decent for a Wear OS device, although not the best we've seen: the 45mm Google Pixel Watch 3 (*see issue 362, p61*) lasted 48 hours with an always-on display.

"While the Watch8 isn't a revolutionary step forward for wearables, the brighter screen is welcome, as are the new health features"

While the Watch8 isn't a revolutionary step forward for wearables, the brighter screen is definitely welcome, as are the new health features. The introduction of Gemini could be useful, too, depending on how you use your watch.

In my view, though, the best thing about the Galaxy Watch8 is the new Classic design. It's a weighty device with a price to match, but its stylish looks and excellent battery life are enough to make it my new favourite Android smartwatch. At the same time, since it still can't match the longevity of the Pixel Watch 3, despite costing rather more, it's a tough sell: with Google's Pixel Watch 4 coming out soon, I suggest you wait and see how that matches up before investing in either version of Samsung's Galaxy Watch8. **DAN BRACAGLIA**

LEFT **The side buttons offer a satisfying tactile response**

ABOVE **The chunky construction means you'll definitely notice it on your wrist**

LEFT **The standard Watch8 has a clean, minimalist design**

SPECIFICATIONS

40mm: 1.3in 438 x 438 AMOLED display • 325mAh battery • 32GB storage • 40 x 8.6 x 43mm (WDH) • 30g. **44mm:** 1.5in 480 x 480 AMOLED display • 435mAh battery • 32GB storage • 44 x 8.6 x 46mm (WDH) • 34g. **Classic:** 1.3in 438 x 438 AMOLED display • 445mAh battery • 64GB storage • 46 x 10.6 x 46mm (WDH) • 64g. **Shared:** Samsung Exynos W1000 processor • 2GB RAM • GPS • NFC • Wi-Fi 4 • Bluetooth 5.3 • optional 4G • 5ATM, IP68 water resistance (50m) • Wear OS • 1yr RTB warranty

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CONTENT CREATION WORKSTATIONS

WORKSTATION TECHNOLOGY CONTINUES TO DEVELOP APACE, SO WE'VE COLLECTED 11 OF THE FASTEST SYSTEMS AT TWO PRICE POINTS TO HELP YOU FIND CREATIVE PC PERFORMANCE NIRVANA

Reviewing PC workstations is always a revelation: like gaming rigs, these are computers that benefit greatly from the latest and greatest performance components. Even though AMD now dominates the CPU side, we're still enjoying a wide range of specifications, because the technology never stops improving.

This year, our test was just late enough to see the latest generation of AMD Ryzen Threadrippers arrive, the 9000 series. The desktop Ryzen equivalent has been around since this time last year, with our first taste in the 2024 workstation labs test. But this time we're also seeing the desktop version with 3D V-Cache. The result of AMD's fast-paced development is that only one system this month, from Lenovo, includes an Intel processor.

AMD is still failing to oust Nvidia in the professional graphics market, however, despite the growing popularity of its consumer cards. Nvidia launched its latest Blackwell GPU generation at the beginning of the year, and quite a few manufacturers have chosen to include the consumer variant. The professional version has also arrived in ultra-high-end 6000 guise, and we test two of these this month, too.

To accommodate the price of all these new premium components, we've raised our price points a lot this year. The lower end is represented by a ceiling of £5,500 exc VAT, while the high end comes in at £11,000 exc VAT. We've also revamped our test suite with the all-new SPECworkstation 4.0, plus the revamped SPECviewperf 15, removing a few tests where there was too much overlap.

The result is a heady blend of content creation workloads from 3D animation to CAD, games design, engineering, scientific software and even some AI inference. So read on to find your perfect workstation workhorse.

CONTRIBUTOR: James Morris

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	Armari Magnetar MC16R9	RECOMMENDED Armari Magnetar MC64T9	InterPro IPW-TW	Lenovo ThinkStation P5 Tower	Lenovo ThinkStation P8 Tower
Overall rating	★★★★☆	★★★★★	★★★★☆	★★★☆☆	★★★★☆
Information					
Price	£3,997 (£4,796 inc VAT)	£10,995 (£13,194 inc VAT)	£5,995 (£7,194 inc VAT)	£3,447 (£4,136 inc VAT)	£10,829 (£12,995 inc VAT)
Price of delivery[1]	Free	Free	£25 (£30 inc VAT)	Free	Free
Supplier	armari.com	armari.com	ipworkstations.com	lenovo.com	lenovo.com
Warranty	3yr RTB (1 month C&R, 2 years parts and 3yr labour)	3yr (1yr C&R plus 2yr RTB, parts and labour)	3yr RTB (parts and labour)	3yr on-site parts and labour	3yr on-site parts and labour
Core components					
Processor	4.3GHz AMD Ryzen 9 9950X3D	4GHz AMD Ryzen Threadripper 9970X	4GHz AMD Ryzen Threadripper 7970X	3.1GHz Intel Xeon w5-2445	4GHz AMD Ryzen Threadripper Pro 7975WX
Memory	128GB DDR5-5600	256GB DDR5-6400	256GB DDR5-5600	128GB DDR5-4800	512GB DDR5-4800
ECC registered?	✗	✗	✗	✗	✗
Motherboard	Asus ProArt X870E-Creator WiFi	Asus Pro WS TRX50-Sage WiFi A	Asus Pro WS TRX50-Sage WiFi	Intel W790	AMD Storm Peak
RAM sockets	4 (2 free)	4 (0 free)	4 (0 free)	8 (4 free)	8 (0 free)
PCI Express 5.0 x16	2 (1 free)	3 (2 free)	5 (4 free)	2 (0 free)	6 (5 free)
PCI Express 4.0 x16	✗	1 (1 free)	✗	3 (3 free)	✗
M.2 sockets	2 (1 free)	3 (1 free)	3 (1 free)	2 (1 free)	2 (0 free)
SATA 600	4 (4 free)	4 (4 free)	8 (8 free)	2 (2 free)	4 (1 free)
Other	✗	✗	1 x U.2 (1 free)	3 x PCIe x4 (3 free)	✗
Graphics					
Make and model	Zotac Nvidia GeForce RTX 5090 32GB Solid OC	Nvidia RTX Pro 6000 Blackwell	Nvidia GeForce RTX 5090	Nvidia RTX 4000 Ada Generation	Nvidia RTX 5000 Ada Generation
Memory	32GB ECC GDDR6	96GB ECC GDDR7	32GB GDDR7	20GB GDDR6	32GB GDDR6
Outputs	3 x DisplayPort 2.1b, 1 x HDMI 2.1a	4 x DisplayPort 2.1b	3 x DisplayPort 2.1b, 1 x HDMI 2.1a	4 x DisplayPort 1.4a	4 x DisplayPort 1.4a
Drives					
SSD make and model	Samsung 9100 Pro Series	Samsung 9100 Pro Series	Samsung 9100 Pro Series	Lenovo UMIS	Kioxia XG8
Nominal capacity	4TB	4TB	1TB	1TB	2TB
Interface	NVMe M.2 PCIe Gen5	NVMe M.2 PCIe Gen5	NVMe M.2 PCIe Gen5	NVMe M.2 PCIe Gen4	NVMe M.2 PCIe Gen4
Secondary SSD make and model	✗	✗	WD Black	✗	Kioxia XG8
Nominal capacity	N/A	N/A	8TB	N/A	2TB
Interface	N/A	N/A	NVMe M.2 PCIe Gen4	N/A	NVMe M.2 PCIe Gen4
Case					
Model (dimensions, WDH)	Antec Flux SE Mid Tower (239 x 484 x 502mm)	Antec Flux SE Mid Tower (239 x 484 x 502mm)	Fractal North XL (240 x 503 x 509mm)	Lenovo ThinkStation P5 TWR (165 x 465 x 447mm)	Lenovo ThinkStation P8 TWR (180 x 508 x 435mm)
PSU make and model (power output)	Thermaltake GF3 Gold (1,650W)	Thermaltake GF3 Gold (1,650W)	Corsair RM1000x V3 (1000W)	HuntKey (1,000W)	Unbranded (1,400W)
CPU cooler	Armari SPX-A63M2PT3 360mm AIO	Armari SPX-AT362OPT3-9RC 360mm AIO/T30 fans	Corsair iCUE H150e RGB Elite 360mm digital water cooler	Lenovo air cooler	Lenovo air cooler
Interfaces					
Ethernet (rear)	1 x 10GbE, 1 x 2.5GbE	1 x 10GbE, 1 x 2.5GbE	1 x 10GbE, 1 x 2.5GbE	1 x 1GbE	1 x 10GbE, 2 x 2.5GbE
Wi-Fi (rear)	Wi-Fi 7	Wi-Fi 7	Wi-Fi 7	✗	✗
USB-C (rear)[2]	2 x USB 4, 1 x USB 3.2 Gen 2x2	2 x USB 4	1 x USB 3.2 Gen 2x2	1 x USB 3.2 Gen 2x2	1 x USB 3.2 Gen 2x2
USB-A (rear)	7 x USB 3.2 Gen 2, 1 x USB 2	6 x USB 3.2 Gen 2, 1 x USB 2	6 x USB 3.2 Gen 2, 2 x USB 2	6 x USB 3.2 Gen 2	3 x USB 3.2 Gen 2, 2 x USB 2
Audio (rear)	3 x 3.5mm	2 x 3.5mm	2 x 3.5mm	2 x 3.5mm	1 x 3.5mm
USB (front)[2]	1 x USB-A 3.2 Gen 1, 1 x USB-C 3.2 Gen 2x2	2 x USB-A 3.2 Gen 1, 1 x USB-C 3.2 Gen 2	2 x USB-A 3.2 Gen 1, 1 x USB-C 3.2 Gen 2	✗	2 x USB-A 3.2 Gen 2, 1 x USB-C 3.2 Gen 2x2
Audio (front)	1 x 3.5mm combo	1 x 3.5mm audio, 1 x 3.5mm mic	1 x 3.5mm audio, 1 x 3.5mm mic	1 x 3.5mm combo	1 x 3.5mm combo
Operating system	Windows 11 Pro 64-bit	Windows 11 Pro 64-bit	Windows 11 Pro 64-bit	Windows 11 Pro 64-bit	Windows 11 Pro 64-bit

[1] To mainland UK. [2] USB 4 = 40Gbits/sec (minimum), USB 3.2 Gen2x2 = 20Gbits/sec, USB 3.2 Gen 2 = 10Gbits/sec, USB 3.2 Gen1 = 5Gbits/sec, USB 2 = 480Mbits/sec

				LABS WINNER	RECOMMENDED	
	PC Specialist Fortis Pro R	**PC Specialist Fortis Goliath R**	**Scan 3XS GWP-G1-TR32**	**Scan 3XS GWP-A1-TR64**	**Wired2Fire TRX50 Extreme 5090 Workstation**	**Workstation Specialists WS AR-X8700**
	★★★★☆	★★★★☆	★★★★☆	★★★★★	★★★★☆	★★★★☆
	£5,400 (£6,480 inc VAT)	£10,800 (£12,960 inc VAT)	£5,500 (£6,600 inc VAT)	£11,000 (£13,200 inc VAT)	£8,333 (£10,000 inc VAT)	£2,978 (£3,574 inc VAT)
	Free	Free	Free	Free	Free	Free
	pcspecialist.co.uk	pcspecialist.co.uk	scan.co.uk/3xs	scan.co.uk/3xs	wired2fire.co.uk	workstationspecialist.com
	3yr C&R (parts and labour)	3yr C&R (parts and labour)	3yr (1yr on-site plus 2yr RTB, parts and labour)	3yr (1yr on-site plus 2yr RTB, parts and labour)	5yr on-site (parts and labour TBC)	3yr RTB (next business day)
	4.3GHz AMD Ryzen 9 9950X3D	4GHz AMD Ryzen Threadripper Pro 7975WX	4GHz AMD Ryzen Threadripper 9970X	3.2GHz AMD Ryzen Threadripper 9980X	3.2GHz AMD Ryzen Threadripper 7980X	4.3GHz AMD Ryzen 9 9950X
	128GB DDR5-4800	256GB DDR5-4800	64GB DDR5-5600	128GB DDR5-5600	256GB DDR5-5600	64GB DDR5-6000
	✓	✓	✗	✗	✗	✗
	Asus ProArt X870E-Creator WiFi	Asus Pro WS WRX90E Sage SE	Asus Pro WS TRX50-Sage WiFi	Asus Pro WS TRX50-Sage WiFi	Asus Pro WS TRX50-Sage WiFi	Asus Prime X870-P
	4 (0 free)	8 (0 free)	4 (0 free)	4 (0 free)	4 (0 free)	4 (2 free)
	2 (0 free)	7 (5 free)	5 (4 free)	5 (4 free)	5 (4 free)	1 (0 free)
	✗	✗	✗	✗	✗	2 (2 free)
	2 (1 free)	4 (3 free)	3 (2 free)	3 (2 free)	3 (2 free)	4 (3 free)
	4 (4 free)	4 (3 free)	8 (8 free)	8 (8 free)	8 (8 free)	2 (2 free)
	✗	2 x SlimSAS (2 free)	1 x U.2 (1 free)	1 x U.2 (1 free)	1 x U.2 (1 free)	✗
	PNY Nvidia RTX 5000 Ada Generation	PNY Nvidia RTX 6000 Ada Generation	Asus GeForce RTX 5090 TUF Gaming	Nvidia RTX Pro 6000 Blackwell	Asus ROG Astral LC GeForce RTX 5090	Nvidia RTX 4000 Ada Generation
	32GB GDDR6	48GB ECC GDDR6	32GB GDDR7	96GB ECC GDDR7	32GB GDDR7	20GB GDDR6
	4 x DisplayPort 1.4a	4 x DisplayPort 1.4a	3 x DisplayPort 2.1b, 2 x HDMI 2.1b	4 x DisplayPort 2.1b	3 x DisplayPort 2.1b, 2 x HDMI 2.1b	4 x DisplayPort 1.4
	Samsung 9100 Pro Series	Samsung 9100 Pro Series	Samsung 9100 Pro Series	Samsung 9100 Pro Series	Samsung 9100 Pro Series	Crucial T705
	2TB	1TB	4TB	4TB	4TB	2TB
	NVMe M.2 PCIe Gen5	NVMe M.2 PCIe Gen5	NVMe M.2 PCIe Gen5	NVMe M.2 PCIe Gen5	NVMe M.2 PCIe Gen5	NVMe M.2 PCIe Gen5
	Samsung 9100 Pro Series	Samsung 9100 Pro Series	✗	✗	✗	✗
	4TB	2TB	N/A	N/A	N/A	N/A
	NVMe M.2 PCIe Gen5	NVMe M.2 PCIe Gen5	N/A	N/A	N/A	N/A
	Fractal Define 7 Black (240 x 547 x 475mm)	Fractal Define 7 XL Black (240 x 604 x 566mm)	Fractal North XL Charcoal Black (240 x 503 x 509mm)	Fractal North XL Charcoal Black (240 x 503 x 509mm)	Antec Flux Pro (245 x 530 x 545mm)	Antec P20CE (220 x 469 x 490mm)
	Corsair RMx Series Modular 80 Plus Gold (1,000W)	Corsair RMx Series Modular 80 Plus Gold (850W)	Corsair RMX1000e 80 Plus Gold (1,000W)	Corsair RMX1000e 80 Plus Gold (1,000W)	be quiet! Dark Power Pro 13 (1,600W)	ATX 80-Plus Platinum (1,000W)
	PCS FrostFlow 200 Series high performance CPU cooler	Enermax Liqtech XTR 360mm water cooler	ThermalTake AW360 AIO liquid cooler	ThermalTake AW360 AIO liquid cooler	SilverStone 360mm XE360-TR5 TR5/SF6 AMD CPU AIO	240mm all-in-one liquid cooler
	1 x 10GbE, 1 x 2.5GbE	2 x 10GbE, 1 x 1GbE	1 x 10GbE, 1 x 2.5GbE	1 x 10GbE, 1 x 2.5GbE	1 x 10GbE, 1 x 2.5GbE	1 x 2.5GbE
	Wi-Fi 7	✗	Wi-Fi 7	Wi-Fi 7	Wi-Fi 7	✗
	2 x USB 4, 1 x USB 3.2 Gen 2x2	2 x USB 4	1 x USB 3.2 Gen 2x2	1 x USB 3.2 Gen 2x2	1 x USB 3.2 Gen 2x2	2 x USB 4
	7 x USB 3.2 Gen 2, 1 x USB 2	6 x USB 3.2 Gen 2, 2 x USB 2	6 x USB 3.2 Gen 2, 2 x USB 2	6 x USB 3.2 Gen 2, 2 x USB 2	6 x USB 3.2 Gen 2, 2 x USB 2	1 x USB 3.2 Gen 2, 3 x USB 3.2 Gen 1, 4 x USB 2.0
	3 x 3.5mm	2 x 3.5mm	2 x 3.5mm, 1 x optical S/PDIF	2 x 3.5mm, 1 x optical S/PDIF	2 x 3.5mm, 1 x optical S/PDIF	3 x 3.5mm
	4 x USB-A 3.2 Gen 1, 1 x USB-C 3.2 Gen 2	4 x USB-A 3.2 Gen 1, 1 x USB-C 3.2 Gen 2	2 x USB-A 3.2 Gen 1, 1 x USB-C 3.2 Gen 2	2 x USB-A 3.2 Gen 1, 1 x USB-C 3.2 Gen 2	1 x USB-A 3.2 Gen 1, 1 x USB-C 3.2 Gen 2x2	2 x USB-A 3.2 Gen 1, 1 x USB-C 3.2 Gen 2
	1 x 3.5mm audio, 1 x 3.5mm mic	1 x 3.5mm audio, 1 x 3.5mm mic	1 x 3.5mm audio, 1 x 3.5mm mic	1 x 3.5mm audio, 1 x 3.5mm mic	1 x 3.5mm combo	1 x 3.5mm audio, 1 x 3.5mm mic
	Windows 11 Pro 64-bit	Windows 11 Pro 64-bit	Windows 11 Pro 64-bit	Windows 11 Pro 64-bit	Windows 11 Pro 64-bit	Windows 11 Pro 64-bit

Six things to look for in a workstation

There are few bigger and more important investments to make than a new workstation, or a fleet of them. Here's what you need to consider before taking the plunge

Workstations are the most powerful desktop PCs around. But there are always budgetary constraints, which means you will need to choose your components wisely based around your workloads and budget. It's no longer necessary to compromise too much between systems that are biased towards real-time graphics display and those aimed at final output. However, you should still spend the most on the components that will benefit your workload the most.

1 PROCESSOR

Processors continue to develop apace. The AMD Ryzen 9000 series arrived last year, but this time we see a few X3D versions with 3D V-Cache, which significantly improves performance with certain workloads. Intel CPUs have moved onto the Core Ultra generation, the first to use a tile configuration like AMD's Zen architecture. However, no manufacturers sent us a system using the desktop Arrow Lake-S version, implying a lack of popularity in the workstation space.

In fact, we have only one Intel CPU in this month's test, and it's a Xeon. While the Xeon has improved with the introduction of the Sapphire Rapids generation, our performance tests with the w5 version this month show that there's a lot more work for Intel to do before it catches up with AMD. The gap is further widening now that the 9000-series AMD Threadripper and Threadripper Pro have arrived.

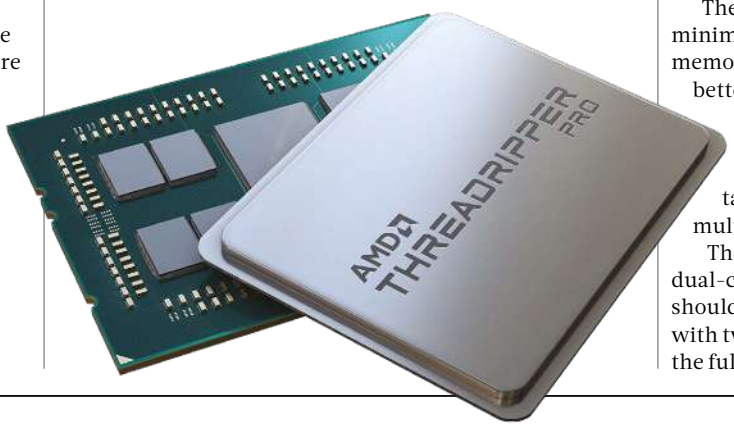
These bring the professional AMD CPUs in line with the technology of the mainstream Ryzen desktop and EPYC server processors. Ostensibly, the new CPUs don't introduce huge changes, and in fact can use the same motherboards (assuming a recent enough BIOS) as the 7000 series. The base clocks are the same, and the core count ceiling is still 64 for the basic Threadripper and 96 for the Pro variant. The amount of L3 cache is the same for the equivalent model and the TDP still sits at 350W. Threadripper CPUs still have 48 PCIe 5.0 plus 24 PCIe 4.0 lanes, whereas the Pro variant has 128 PCIe 5.0 lanes. The non-Pro has quad-channel memory controller, whereas Pro is eight-channel.

ABOVE Workstations are the powerhouses of the computing world, with prices to match

The Boost clock has been raised to 5.4GHz across the board for the 9000 series Threadrippers, thanks to the use of Zen 5 cores rather than the previous Zen 4. There is a little more L1 cache (80KB rather than 64KB). The manufacturing process has dropped from 5nm to 4nm, which usually means greater headroom for higher clock speeds across more cores at the same time. This has resulted in a notable increase in performance of up to 30%.

Always ensure that the memory configuration takes full advantage of a system's multi-channel memory capabilities

Our labs test was entering its later stages as the 9000 series arrived, so we have a mixture of 7000 and 9000 generation Threadrippers. If you can afford one, these are the optimal choice. However, while you can get 12- and 16-core Pro versions, these are expensive and the basic Threadripper starts at 24 cores, so a desktop 16-core Ryzen 9 9950X or 9950X3D is the best choice on a tight budget. As our tests show, it's still a capable and flexible CPU for a wide range of workloads. The 32- and 64-core Threadrippers in our test are particularly strong for doing multiple things at once, so you can encode video or render 3D, and the system should still be available for design work. It's telling, however, that only two manufacturers have opted for the Ryzen Threadripper Pro. You need to be running software that benefits from the eight-channel memory and need more PCIe 5.0 lanes for the additional price of this CPU range to be worth the money.



BELOW AMD's 9000-series Threadripper and Threadripper Pro have widened the gap between AMD and Intel

2 MEMORY

DDR5 memory is now the de facto standard, and while a variety of clock speeds are available this only makes a small performance difference. More important is the quantity installed and how many channels can be addressed in parallel.

These days, 64GB is becoming the minimum as software becomes more memory-hungry, and more is always better. We have systems with up to 512GB of memory this month. However, always ensure that the memory configuration takes full advantage of a system's multi-channel memory capabilities.

The standard AMD Ryzen offers dual-channel memory, so DIMMs should be added as matching pairs, with two DIMMs sufficient to provide the full bandwidth benefit. The Ryzen

Threadripper has a quad-channel memory controller, so memory should be added as matching quartets. For the Threadripper Pro, you need eight identical memory modules – otherwise you're wasting one of the reasons why you paid extra for the Pro over the standard model.

3 GRAPHICS ACCELERATION

Most content creation will require live previews of design work. If this involves 3D, such as film or TV animation, CAD, engineering or product design, you're going to need a fast graphics accelerator. Professional GPUs are more expensive than consumer-grade ones, and for some types of activity the latter might be a valid choice. For example, game developers may want to test their designs on the same PC they use for creation, so having a gaming card makes sense.

However, professional graphics card ranges generally have longer warranties and come with support for professional software. They will also be optimised for this software. Particularly telling examples are Siemens NX and SolidWorks, which run very slowly on consumer-grade GPUs with gaming drivers.

Finally, this year we have started to see graphics accelerators with native support for PCIe 5.0. Motherboards have offered this for a few years now, but the Nvidia GeForce RTX 5090 found in several systems in this test was the first GPU to offer direct support. The Nvidia RTX Pro 6000 Blackwell now does as well, while previous generations of Nvidia RTX professional graphics don't.

In previous years we generally saw a few AMD graphics cards, but this test has none. While AMD is making inroads in the server accelerator market with its Instinct GPUs and the consumer market with its Radeon RX 9000 series, the company has never been able to oust Nvidia's dominance in the professional graphics market. We still await a professional variant of the RX 9000 series.

Nvidia's lead will have been further cemented by the arrival of the Blackwell generation of Nvidia RTX Pro accelerators. The GeForce RTX 5090 also uses the Nvidia Blackwell technology, which brings support for GDDR7 memory (the previous generation uses GDDR6). This doubles memory performance and uses PAM3 signalling for more efficient data transmission. Together, these provide faster AI processing and rendering.

For now, the Nvidia RTX 4000 Ada Generation will continue to be available and is a solid baseline for high-end professional acceleration for content creation, costing around £1,200. The Blackwell 4000 is over £200 more expensive. The 5000 Ada Generation is a considerable price hike at around £3,700. The all-conquering RTX Pro 6000 Blackwell is insanely expensive at close to £7,900.

ABOVE Nvidia still leads the way when it comes to professional graphics cards

This is why the GeForce RTX 5090 is proving popular, as it provides solid Blackwell performance for around £2,200. Depending on the workloads you run, it could be a valid economisation, although the RTX Pro 6000 Blackwell is unbeatable in most areas.

Professional GPUs are more expensive than consumer-grade ones, and for some types of activity the latter might be a valid choice

4 STORAGE

Most workstations in the past used to combine a fast bootup and application drive with cheaper secondary storage for data. However, as the capacity of quick SSDs has increased and their cost has gone down, this is less of a necessity, and many systems this month provide one storage device. If you work with huge video files, you'll still want a lot of capacity. But otherwise, a 2TB drive will keep things going and a 4TB one will be adequate for a long time.

BELOW The popular Antec Flux chassis is used in a number of systems this month

The latest PCIe 5.0 NVMe M.2 SSDs can deliver well over 14,000MB/sec reading and often get close to this for writing, too. Even the quickest SATA conventional hard disks will provide around 40x lower throughput. They still offer the most capacity for the money, and if you need more than 4TB then flash storage is going to be extremely expensive. A sensible way of working these days is to have enough flash storage in your system for a few projects and then use a large USB-C external device as backup. Archiving and retrieval may take a little time, but your workflow will be rapid on the system itself. No system included a hard drive this year, and we wonder if we will ever see one again in a content creation workstation.

5 CHASSIS

Chassis design continues to develop, and we see a few new options in this test. Antec is proving popular again, with the Flux used by several integrators, plus the solid P20CE in one instance. Fractal is still a firm favourite, however, with the Define 7 and North both used in multiple systems. These are all superb cases.

The need for installing many large drives has receded now that so many motherboards support three M.2 devices and NVMe drives up to 4TB are increasingly affordable. Your chassis decision will be more about airflow. The Antec Flux has a fan mount at the bottom, for example, to drive air upwards. Lenovo is the only company this month to provide a bespoke chassis design – and it's very good, too. All the chassis in this test have handy tool-free access and look a bit more interesting than a black obelisk.

6 POWER SUPPLY

The final component to consider for a workstation is the power supply. These are performance-oriented systems and they eat watts for breakfast, so you need to be sure that your PSU can cope. A 750W supply is a bare minimum, and these days more is preferable, as CPUs and GPUs continue to push the envelope on consumption. For a Threadripper system, over 1,000W is recommended.

Also take note of efficiency. At least Gold is essential, and Platinum is even better. This indicates that very little power will be lost converting from 240V AC to the various DC feeds within the computer.

How we test and graphs

We always want to give the broadest possible workstation advice, so we use a wide variety of software for testing – and this year we've added even more with a huge new test suite from SPEC (the non-profit Standard Performance Evaluation Corporation).

To start, we ran our standard PC Pro Media Benchmark suite to assess image-processing and video-encoding abilities, and then multitasking (see the results on p95). Each of these categories has an individual score, which indicates relative speed compared to a Core i7-4760K desktop PC with 8GB of RAM. If a machine scores 150 in a test, it's 50% faster than the reference PC. All these results are combined into an overall score, giving an indication of ability in these content-creation tasks as well as general activities. This month we have systems that are over ten times faster than our baseline.

On top of our regular benchmark suite, we added tests specifically aimed at a range of higher-end workstation tasks. To test 3D modelling in all the main content creation workloads, we now use the brand new SPECviewperf 15, released in May 2025, which runs OpenGL viewsets (and in some cases DirectX) based on popular 3D content creation, engineering and medical applications. These include Autodesk 3ds Max and Maya, Blender, the Unreal Engine, Chaos Enscape, PTC's Creo, plus Dassault Systèmes CATIA and SolidWorks.

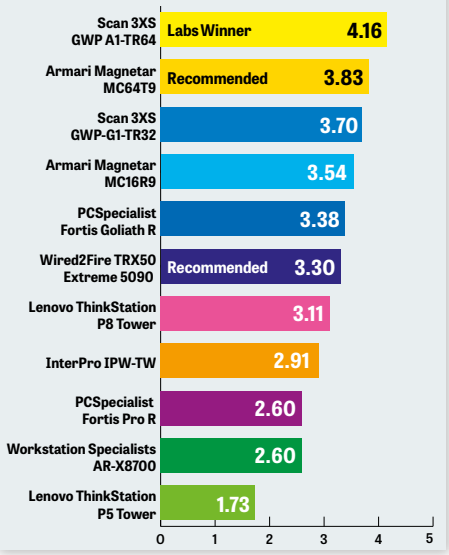
Maxon Cinebench 2024's 3D rendering test runs on the GPU, a single CPU core and then across all available CPU threads, to show how much multithreaded performance the system has to offer. We also tested CPU 3D rendering using the popular Blender (version 4.4.3 at the time of testing) and a frame from the *Cosmos Laundromat* animated movie, codenamed Project Gooseberry. This is a gruelling, lengthy render that taxes cooling and can cause core throttling if this isn't sufficient. But GPU rendering is slowly becoming used in live production, so we also tested GPU rendering with the same Blender frame, using CUDA acceleration for Nvidia cards and HIP for AMD ones.

Also new this year is SPECworkstation 4.0, a huge suite of tests that cover 23 different applications from file compression to 3D design, to image filtering, to machine learning, to video encoding, rendering, code compilation and molecular dynamics. The results are divided into 11 categories across seven industry verticals and four hardware subsystems. You can find which system is best for AI/ML, which reigns supreme for life sciences, and which dominates media and entertainment, for example.

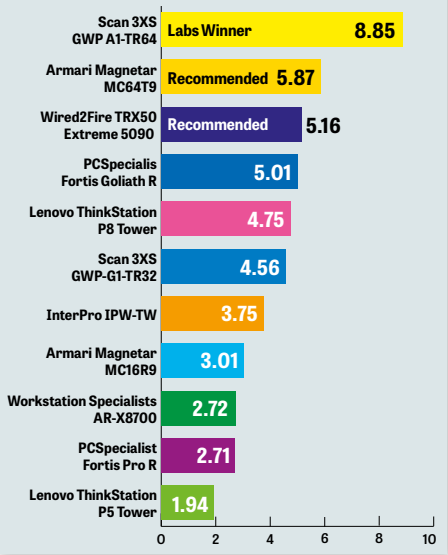
We also tested the raw performance of each workstation's storage with the CrystalDiskMark 9.0.1 benchmark. The result is an exhaustive set of test scores showing which type of content creation software and activity each workstation is best suited for.

SPECworkstation 4.0 – Verticals

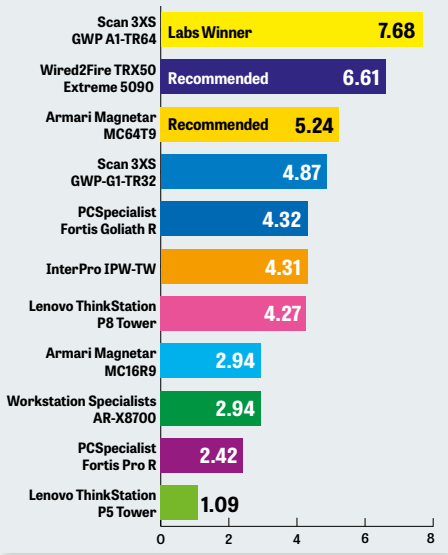
AI/Machine Learning



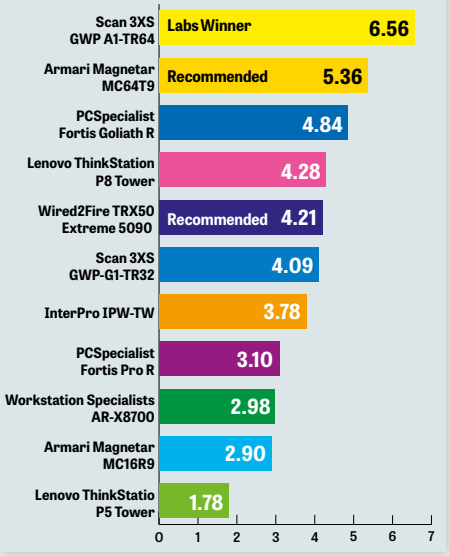
Energy



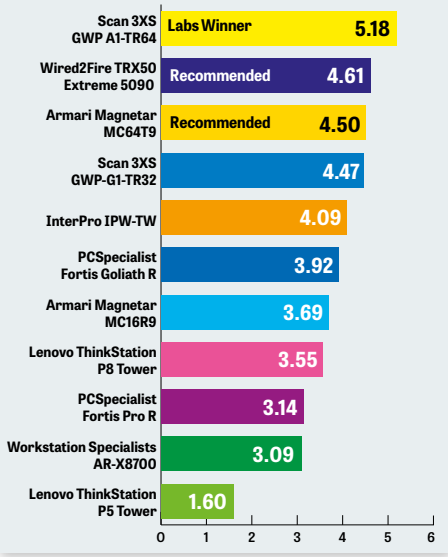
Financial Services



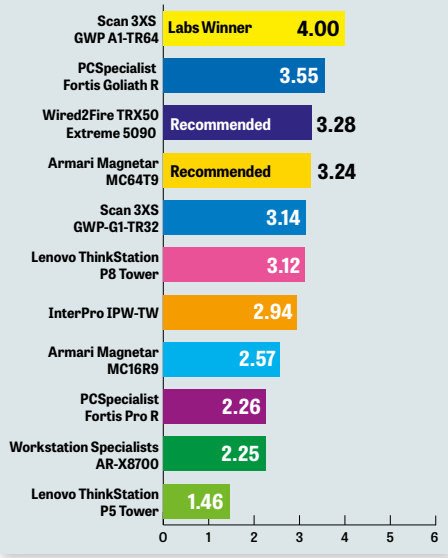
Life Sciences



Media & Entertainment

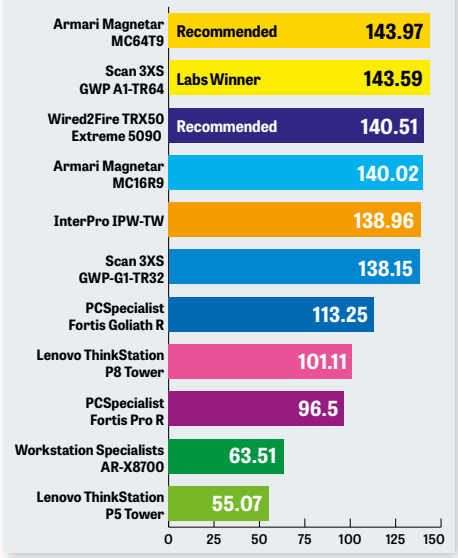


Product Design



SPECviewperf 15 viewsets

3dsmax-08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Armari Magnetar MC16R9 140.02
InterPro IPW-TW 138.96
Scan 3XS GWP-G1-TR32 138.15
PCSpecialist Fortis Goliath R 113.25
Lenovo ThinkStation P8 Tower 101.11
PCSpecialist Fortis Pro R 96.5
Workstation Specialists AR-X8700 63.51
Lenovo ThinkStation P5 Tower 55.07
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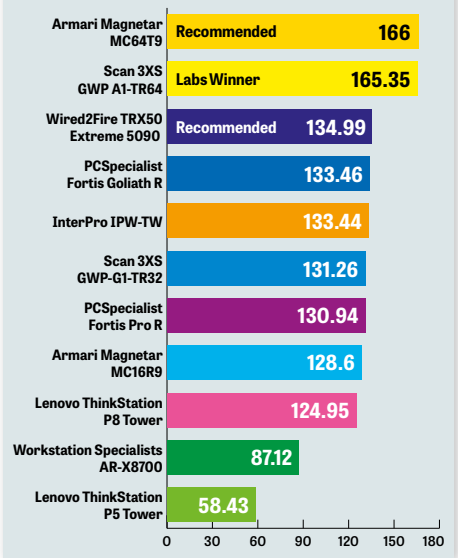
catia-07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Scan 3XS GWP-G1-TR32 131.26
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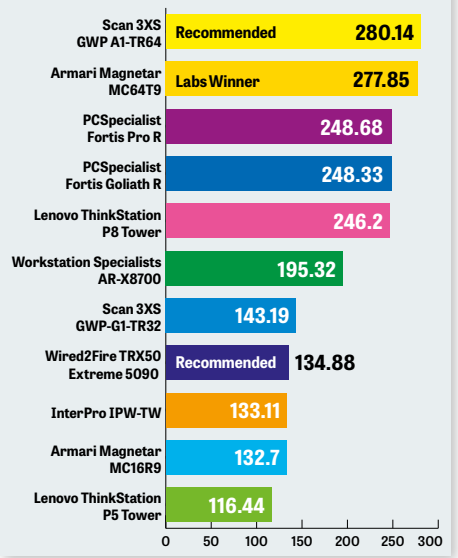
creo-04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Workstation Specialists AR-X8700 195.32
Scan 3XS GWP-G1-TR32 143.19
Wired2Fire TRX50 Extreme 5090 Recommended 134.88
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Lenovo ThinkStation P5 Tower 116.44
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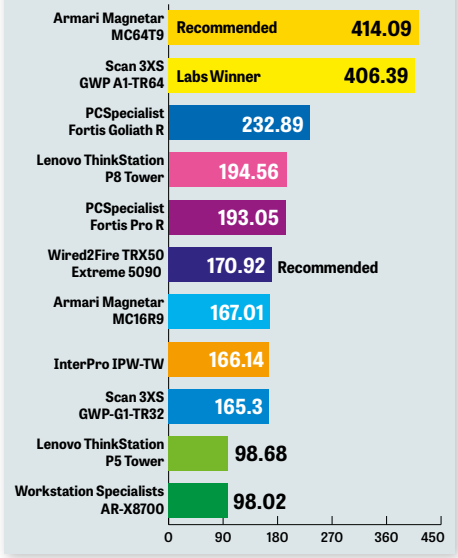
energy-04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InterPro IPW-TW 166.14
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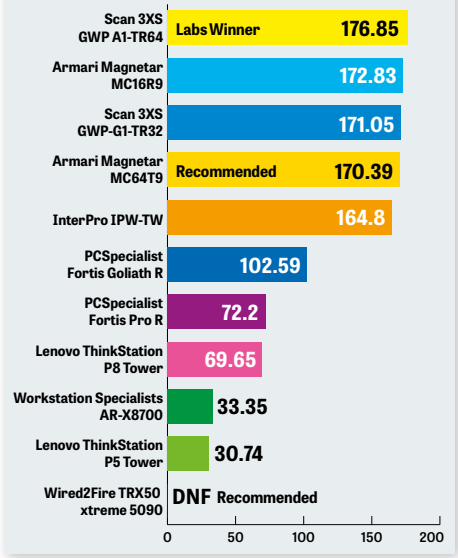
maya-07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PCSpecialist Fortis Pro R 72.2
Lenovo ThinkStation P8 Tower 69.65
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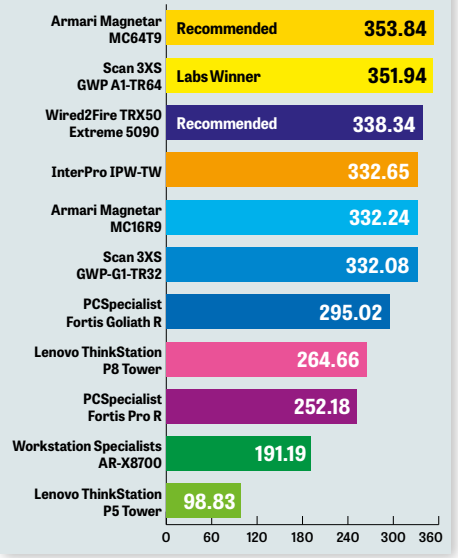
maya-07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Armari Magnetar MC16R9 332.24
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PCSpecialist Fortis Goliath R 295.02
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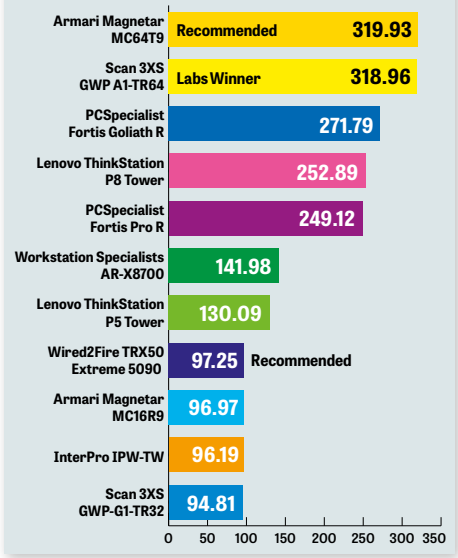
medical-04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Workstation Specialists AR-X8700 141.98
Lenovo ThinkStation P5 Tower 130.09
Wired2Fire TRX50 Extreme 5090 97.25 Recommended
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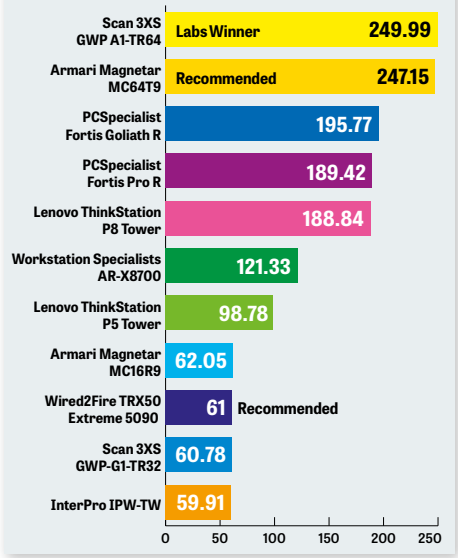
solidworks-08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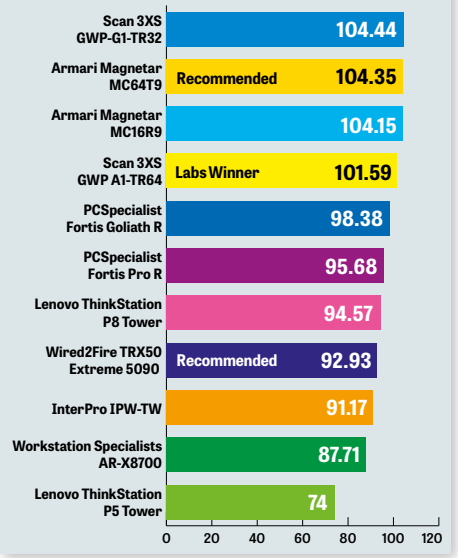
unreal-engine-01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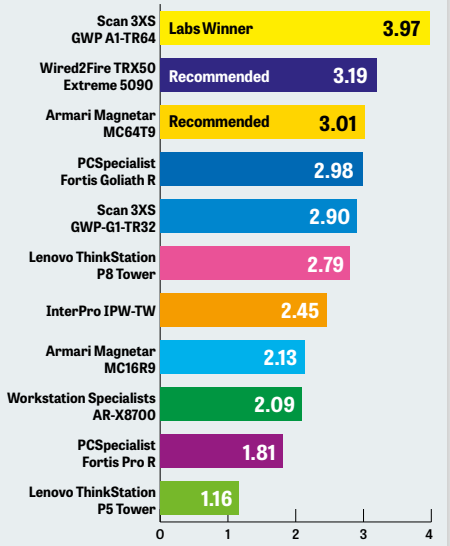
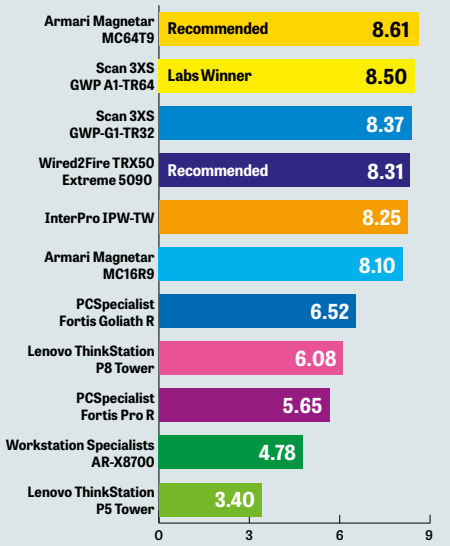
PCSpecialist Fortis Goliath R 98.38
PCSpecialist Fortis Pro R 95.68
Lenovo ThinkStation P8 Tower 94.57
Wired2Fire TRX50 Extreme 5090 Recommended 92.93
InterPro IPW-TW 91.17
Workstation Specialists AR-X8700 87.71
Lenovo ThinkStation P5 Tower 74
0 20 40 60 80 100 120

SPECworkstation 4.0 – Hardware Subsystems

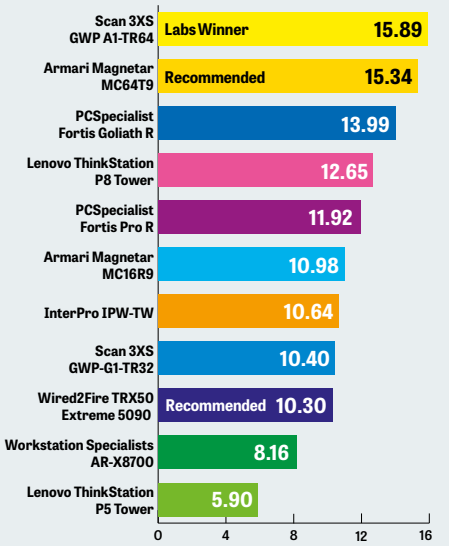
CPU



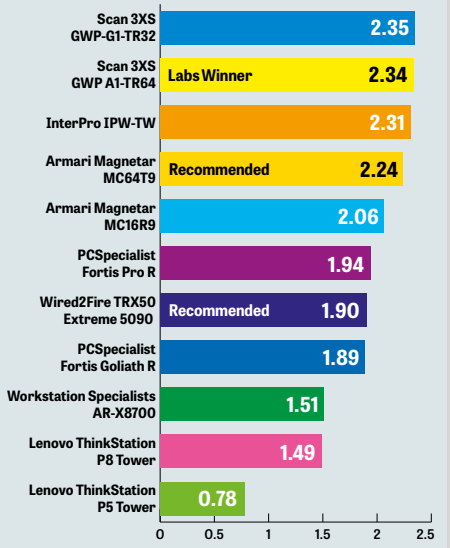
Accelerator



Graphics

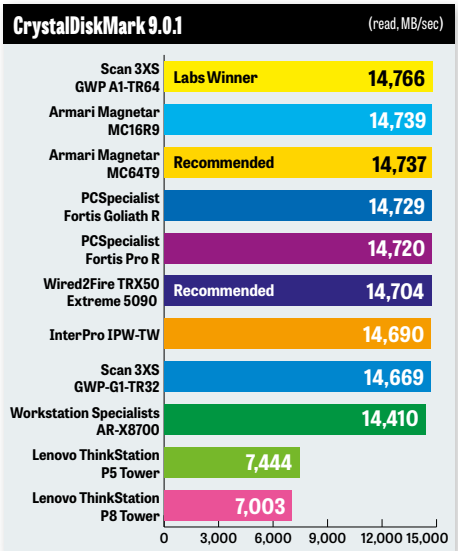


Storage

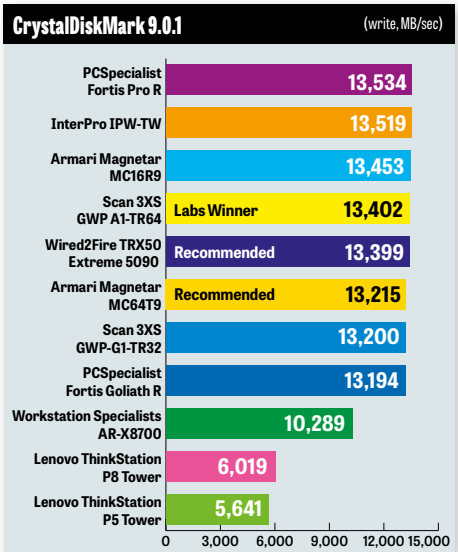


Primary SSD speed

CrystalDiskMark 9.0.1 (read, MB/sec)

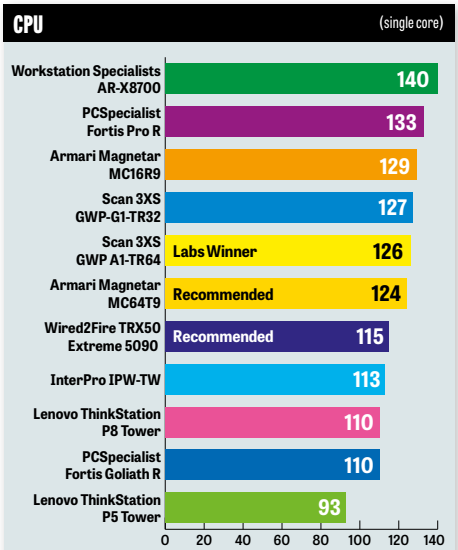


CrystalDiskMark 9.0.1 (write, MB/sec)

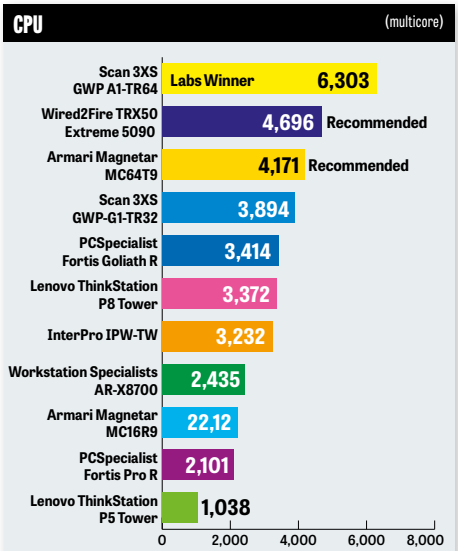


Cinebench 2024

CPU (single core)



CPU (multicore)



Blender Gooseberry 4.2

CPU render (time to complete)

AMD Ryzen Threadripper 9000 series: the lowdown

We compare the new top-end chip with its predecessor and reveal the key differences between the generations

AMD is taking full advantage of the phrase "make hay while the sun shines". While Intel is facing numerous struggles, AMD is concentrating on its core strengths of making extremely fast processors. And that includes its top-end desktop chips, the Threadripper series designed for workstations.

AMD announced the upgraded Ryzen Threadripper 9000 Series at the Computex technology show in Taiwan in June, with the official launch in late July, along with the Pro-variants. We haven't yet seen samples of these, but the top-end 9995WX is a monster with 96 cores.

Thanks to Wired2Fire, which received a Threadripper 9980X sample as we were going to press and upgraded its TRX50 Extreme 5090 Workstation with it, we could see exactly what uplift this new chip provided compared with the 7980X when supported by 128GB of DDR5-5600 RAM and a liquid-cooled RTX 5090 GPU. Note that the 9000 series supports up to DDR5-6400 memory, which would provide another marginal boost.

Core differences

The biggest change between the 7000 series and the 9000 series is the move from its Zen 4 architecture to Zen 5. AMD claims this provides up to 22% more performance in multithreaded workloads, while "true" support for AVX-512 builds in 512-bit instructions to accelerate workloads such as AI and machine learning, cryptography, scientific simulations and video encoding. We say "true" because Zen 4 included partial AVX-512 support, emulating 512-bit instructions using two 256-bit operations.

AMD made big claims about being "up to 83% faster" than Intel's equivalent Xeon when rendering, backing it up with claimed results in Cinebench 2024 multithreaded results. It certainly extends its lead considerably. We have only one Xeon workstation this month, Lenovo's ThinkStation P5 Tower with a low-end, 10-core Xeon w5-2445 inside, and that returned a miserly 1,038 in the Cinebench test. Compare that to 4,696 in the Wired2Fire with a 64-core Ryzen Threadripper 7980X inside – jumping to 5,708 with a 64-core Ryzen Threadripper 9980X.

A fairer comparison is with Intel's 26-core Xeon w7-2595X, which we reviewed last year (*see issue 363, p52*). This returned 2,625 in Cinebench 2024 multicore, so less than half as fast as the 9980X inside Wired2Fire's workstation. We haven't yet tested a 60-core Xeon w9-3595X chip, which is what AMD compares the 9980X to, but independent tests by Puget Systems quote a score of 3,764.

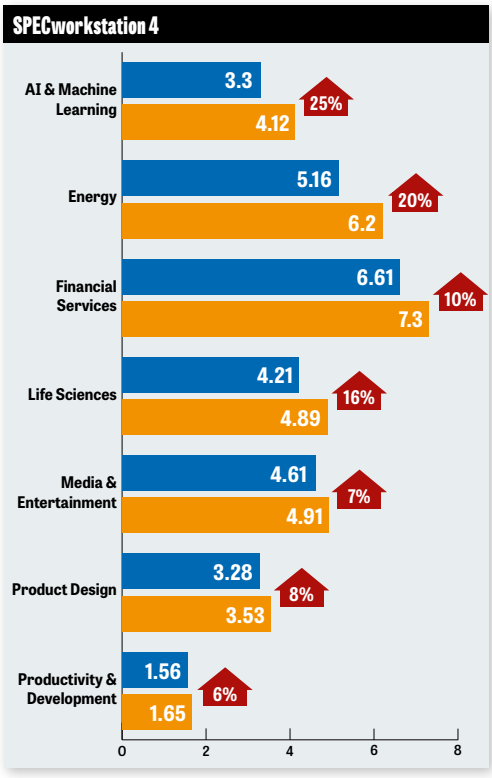
ABOVE AMD's 9000 series Threadripper boosts performance across the board

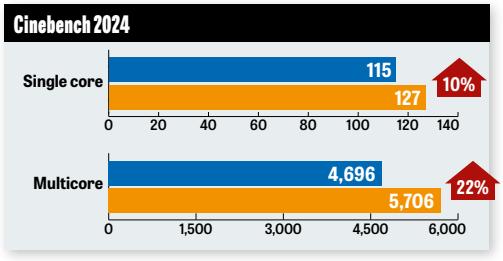
Uplift in all areas

Cinebench is a great test of raw CPU performance, but we were more interested to see how the 9980X boosted performance versus the 7980X across areas such as 3D CAD, content creation, software development and visualisation. Fortunately, the new SPECworkstation 4.0 benchmarks provide a clear comparison here, and the graphs on this page tell the story. In short, there isn't an area where the Zen 5 architecture fails to make a difference.

You also benefit from a frequency boost. Despite the Threadripper 7000 and 9000 series chips sharing the same 350W thermal design power (TDP), the shift from a 5nm production process to 4nm means that AMD can boost the frequencies up to 5.4GHz instead of 5.1GHz. That's across all three chips in the 9000 series: the 64-core 9980X we tested, plus the 32-core 9970X and 24-core 9960X. These are all drop-in replacements for the 7980X, 7970X and 7960X.

All of which means that AMD lives up to its hype with the Ryzen Threadripper 9000 series, despite having the same 256MB of L3 cache and sticking to identical core counts across the three processors in the family (although you do get support for 80 lanes of PCIe 5.0 rather than 48). Intel already had some catching up to do. Now, there's a bigger gap than ever before.





ARMARI MAGNETAR MC16R9

An excellent workstation for the money, particularly for 3D animation and gaming

SCORE ★★★★☆

PRICE £3,997 (£4,796 inc VAT)
from armari.com

Armari has opted for the desktop Ryzen 9 rather than workstation-oriented Ryzen Threadripper for its lower-cost entry this month. It's the latest version with 3D V-Cache, which can boost performance with certain software.

The Ryzen 9 9950X3D has the same 16 cores (32 threads) as the standard 9950X, running at a base 4.3GHz with a 5.7GHz boost, but the L3 cache is doubled to 128MB. Armari partners this with an extremely generous 128GB of 5,600MHz DDR5 memory, supplied as two 64GB modules. Even better, the Asus ProArt X870E-Creator WiFi motherboard has four DIMM slots, so you can add more easily.

Like many other systems in this category, Armari opted for consumer-grade GeForce RTX 5090 graphics, in this case from Zotac. This is a powerful GPU, built on Nvidia's latest Blackwell technology, boasting a huge 21,760 CUDA cores and 32GB of GDDR7 memory with 1,792GB/sec bandwidth.

The Antec Flux SE chassis is a solid choice for these components as it has a fan at the bottom to drive air up through the system. Armari has also included a 1,650W Thermaltake GF3 Gold PSU so you won't have to worry about overburdening the system.

ABOVE The MC16R9 is a capable, well-priced workstation

Only a single storage device has been included, but the model chosen is in good company: eight systems here use a Samsung 9100 Pro series NVMe M.2 drive. In this case, the 4TB version provides rapid sustained reading at 14,739MB/sec and writing at 13,453MB/sec in CrystalDiskMark.

If you run everyday media software, the Ryzen 9 is a solid choice. Its score of 985 in the *PC Pro* benchmarks beats some Threadripper CPUs with far more cores. It falls behind in the multicore Maxon Cinebench 2024 render, with 2,212, and this is reflected in a Blender Gooseberry render time of 4mins 13secs. The SPECworkstation 4.0 verticals are also more modest, although this CPU holds its own in Productivity & Development (including software coding), and the AI/Machine Learning vertical isn't far off systems wielding RTX Pro 6000 Blackwell GPUs.

The GeForce RTX 5090 is still a powerful accelerator for 3D animation and modelling, as shown by the Maya and 3ds Max SPECviewperf 15 viewports, although it's not optimal for CAD or product design, particularly SolidWorks.

This system comes in well below the £5,500 mark at under £4,000 exc VAT. Although the Magnetar MC16R9 isn't a winner this month, it's a very capable workstation for the money.

INTERPRO IPW-TW

An impressive workstation that will only get better with the latest Threadripper

SCORE ★★★★☆

PRICE £5,995 (£7,194 inc VAT)
from ipworkstations.com

InterPro is a regular entrant to our annual workstation Labs, always providing solid specs for content creators. Its IPW-TW brings together well-balanced components that offer strong performance in visualisation and other media workloads. The CPU is from AMD's Ryzen Threadripper 7000 series, and it's likely that InterPro will upgrade to the 9000 series by the time you read this. The 7970X offers 32 cores (64 threads) running at a base 4GHz with a 5.3GHz boost frequency. This is partnered with 256GB of 5,600MHz DDR5 memory, supplied as four 64GB ECC Registered modules. These take up all the DIMM slots on the Asus motherboard, but you probably won't need more memory. More to the point, it satisfies the requirement for the Threadripper's quad-channel memory controller.

InterPro has taken the consumer-oriented option with its graphics, and what a potent GPU it is. The GeForce RTX 5090 is the current pinnacle of Nvidia's consumer accelerators and is powered by the recently released Blackwell generation. It boasts 21,760 CUDA cores and 32GB of GDDR7 memory with 1,792GB/sec bandwidth.

The Fractal North XL chassis is more sober looking than some this month, but don't be put off: it's an excellent choice, with plenty of space for airflow. InterPro is also one of the few manufacturers to provide two storage devices, both NVMe M.2 SSDs. A PCIe 5.0-supporting Samsung 9100 Pro Series 1TB drive takes care of the operating system and software, while a PCIe 4.0 WD Black provides 8TB of data storage. In CrystalDiskMark 9.0.1, the former delivered sustained reading at 14,690MB/sec and writing at 13,519MB/sec, while the latter managed 7,211MB/sec writing and 6,678MB/sec reading.

ABOVE The InterPro system is due to be upgraded to the new Threadripper soon

With its previous-generation CPU, the InterPro wasn't going to win any performance tests this month, but it still managed 881 overall in our Media benchmarks. The Maxon Cinebench result of 3,232 was very respectable, with a Blender Gooseberry CPU render time of just 2mins 41secs. The Media & Entertainment score of 4.09 in SPECworkstation 4.0 was also good, reflecting the GPU's talents. The SPECviewperf 15 results also showed the GeForce RTX 5090 is capable for 3D animation, albeit not so much for CAD.

InterPro went £495 beyond our £5,500 limit with this system but that's essentially because of the secondary SSD (which costs over £500 on its own). This is still a great workstation, and an upgrade to the latest Threadripper 9000 series would put it among the best this month.

LENOVO THINKSTATION P5 TOWER

Great design, but Intel's Xeon can't compete with AMD's processors

SCORE ★★★☆☆

PRICE £3,447 (£4,136 inc VAT)
from lenovo.com

The Lenovo ThinkStation P5 is a fine workstation in many ways, but also showcases the current gulf between Intel and AMD when it comes to workstation processors.

This system accommodates Xeons from W3 to W7, including the W7-2595X we tested last year (*see issue 363, p52*). Even that CPU couldn't beat AMD's 7000-Series Threadripper, and this system was supplied with a more modest W5-2445. This is a 10-core CPU with a base clock of 3.1GHz and a maximum Turbo Boost frequency of 4.6GHz. AMD's desktop Ryzen systems this month offer 16 cores with a base 4.3GHz speed, so the Xeon is immediately at a disadvantage.

The only storage device is a 1TB SSD. This is Lenovo's own LUMIS NVMe M.2 drive, which supports PCIe 4.0 speeds. It's a great SSD in its class, delivering 7,444MB/sec sustained reading alongside 5,641MB/sec writing, but that's half what PCIe 5.0 NVMe drives can deliver. The Xeon W5 support does support this, so it's a shame that the P5 doesn't offer the faster option.

Only Nvidia graphics are available with the P5, with choices ranging from the T400 to RTX 5000 Ada Generation or two A5500 GPUs. Our system came with an RTX 4000 Ada Generation, which makes sense for this spec. This GPU sports a reasonable 6,144 CUDA cores and 20GB of GDDR6 memory with 360GB/sec of bandwidth.

ABOVE The P5 Tower is a well-designed system that's held back by its CPU

Unsurprisingly, the Xeon CPU let this system down in our benchmarks, with a *PC Pro* Media Benchmark result of only 458. The Cinebench 2024 multithreaded render score was just 1,038, half of what the Ryzen 9 9950X is capable of. This is underlined by the Blender CPU render time of 11mins 17secs – over twice as long as a Ryzen 9 9950X. The SPECworkstation 4 results are similarly mediocre compared to other workstations this month.

While the Nvidia RTX 4000 Ada Generation is a solid option for 3D modelling workloads, even this is held back by the Xeon CPU's limitations. The SPECviewperf 15 scores are respectable in general, but lag behind the Workstation Specialists system with the same GPU.

On the plus side, the P5 Tower has a great chassis design, packing its components into a more compact space than other systems this month, although there are no USB ports on the front. It's also £2,000 below our £5,500 exc VAT price ceiling, so you could bump up the spec for better performance. Sadly, you still won't be able to avoid the current shortcomings of Intel's workstation processors.

PCSPECIALIST FORTIS PRO R

A competent component selection, but it falls behind other systems in its class

SCORE ★★★★☆

PRICE £5,400 (£6,480 inc VAT)
from pcspecialist.co.uk

PCSpecialist always puts together credible specs, with the Fortis Pro R combining a capable desktop processor with professional graphics.

It includes AMD's Ryzen 9 9950X3D, which is the variant with 3D V-cache. Although this CPU's 16 cores (32 threads), base clock speed of 4.3GHz and boost frequency of 5.7GHz are all the same as the non-3D 9950X, it has 128MB instead of 64MB of L3 cache.

It's backed by 128GB of 4,800MHz DDR5 memory. This should be enough for the lifetime of the system, which is lucky because the RAM is supplied as a quartet of 32GB modules, filling all four DIMM slots on the Asus ProArt X870E-Creator WiFi motherboard.

Most manufacturers have opted for the power (with a few drawbacks) of consumer-grade graphics for their £5,500 exc VAT systems in this test, but PCSpecialist has gone in the other direction. For 3D acceleration, the Fortis Pro incorporates an Nvidia RTX 5000 Ada Generation card. This is behind the Blackwell cards in technology, but it's still a high-end option offering 12,800 CUDA cores and 32GB of GDDR6 frame buffer providing 576GB/sec throughput.

The Fractal Define 7 Black chassis used by the Fortis Pro R was a frequent choice in previous workstation Labs tests, but PCSpecialist is the only company to use it this year. It's still a sensible choice, with a variety of storage drive mount options. However, the Fortis Pro R focuses on M.2 NVMe, with two Samsung 9100 Pro Series PCIe 5.0 SSDs included. There's a 2TB version for operating system and applications, plus a 4TB version for data. In CrystalDiskMark 9.0.1, the former delivered sustained reading at 14,720MB/sec and writing at 13,534MB/sec reading, while the latter managed an almost identical 14,720MB/sec and 13,426MB/sec respectively.

ABOVE The Fortis R is a competent if slightly underpowered choice

Despite strong component choices, the Fortis Pro R achieved only 744 in our Media Benchmarks. The Maxon Cinebench 2024 multicore score of 2,101 and Blender Gooseberry CPU render time of 4mins 34secs were also behind our expectations, and SPECworkstation 4.0 results were good rather than exceptional across all Verticals. However, the Nvidia RTX 5000 Ada Generation delivers strong product design performance in SPECviewperf 15 compared to the GeForce cards this month and decent results in other viewsets.

Overall, while the PC Specialist Fortis R is a competent workstation, there are higher-performing choices in this price bracket this month.

SCAN 3XS GWP-G1-TF32

Hugely powerful for the money, optimised for 3D animation and games design

SCORE ★★★★☆

PRICE £5,500 (£6,600 inc VAT)
from scan.co.uk/3xs

ABOVE **The potent Threadripper 9970X makes this system a fine choice for 3D work**

Both of Scan's entries this month take advantage of its early access to the Threadripper 9000 series. At this price it's the 32-core variant, while graphics come from Nvidia's consumer range – but this is still an incredibly potent piece of kit.

The Threadripper 9970X offers 32 cores (64 threads) with a base 4GHz clock and a 5.4GHz boost. This combines with 64GB of 5,600MHz DDR5 memory supplied as four 16GB DIMMs to take advantage of the processor's quad-channel bandwidth. This is a little below what we would like for a 32-core processor.

To keep costs down, Scan has opted for consumer-grade graphics with the 3XS GWP-G1-TF32, but it's a powerful example. The Asus Nvidia GeForce RTX 5090 TUF Gaming uses the latest Blackwell technology, offering a huge 21,760 CUDA cores and 32GB of GDDR7 memory with 1,792GB/sec bandwidth. It also supports PCIe 5.0.

Scan uses the same superb Fractal North XL Charcoal Black chassis as its more expensive entrant, and the storage is the same too – a single 4TB Samsung 9100 Pro Series NVMe drive supporting PCIe 5.0. This delivered superfast 14,669MB/sec reading speeds and 13,200MB/sec writing in CrystalDiskMark 9.0.1.

Despite having half as many cores, the 3XS GWP-G1-TF32 beat Scan's more expensive entry in our Media Benchmarks, achieving 1,010. For media workloads needing fewer, faster cores, the 32-core option is the sweet spot, with better image editing and video encoding. However, with the fully multithreaded Cinebench 2024 multicore render, the score of 3,894 shows where 32 cores lost to 64, echoed in the Blender Gooseberry render time of 2mins 26secs.

Similarly, this system was behind the more expensive Scan offering in every SPECworkstation 4.0 vertical, particularly Life Sciences and Energy. The consumer-grade graphics accelerator acquitted itself well in 3D animation SPECviewperf 15 workloads, with 143.59 in 3dsmax-08, 108.92 in blender-01, and 332.08 in maya-07. However, the result of 60.78 in solidworks-08 is disappointing and other CAD workloads show that you'd be better off with professional Nvidia RTX graphics for CAD and engineering.

That aside, this is a capable system for the money. If you're a 3D animator or games designer you'll be able to model with supremely smooth viewports and even render output in the background while you're doing it, making the Scan 3XS GWP-G1-TF32 well worth considering.

WORKSTATION SPECIALISTS WS AR-X8700

A great buy if you're on a lower budget, but a lack of firepower holds it back

SCORE ★★★★☆

PRICE £2,978 (£3,574 inc VAT)
from workstationspecialist.com

ABOVE **The system comes in well below our £5,500 price point**

Workstation Specialists is a regular in our labs test, with a solid focus on professional content creation systems. The WS AR-X8700 is another PC that delivers sensible components for the price.

Rather than the more expensive 3D V-cache version of the AMD Ryzen 9, Workstation Specialists has chosen the basic 9950X. This offers 16 cores (32 threads), along with a 4.3GHz base clock with 5.7GHz boost frequency, but it comes with 64MB of L3 cache rather than 128MB. The CPU is partnered with a decent 64GB of 6,000MHz DDR5 memory, supplied as two 32GB modules. Two DIMM slots remain free if you want to upgrade in the future.

Instead of the Blackwell-based consumer-grade Nvidia GeForce RTX 5090, Nvidia's professional RTX 4000 Ada Generation has 6,144 CUDA cores and 20GB of GDDR6 frame buffer, but bandwidth is only 360GB/sec and there's no support for PCIe 5.0, just 4.0. This accelerator is some distance behind the Blackwell-based GPUs this month in terms of raw power.

The PC has one of the smallest and lightest chassis this month, but we still like it. The Antec P20CE looks professional and offers four storage bays, with good airflow. As standard, there's a modest but adequate 2TB Crucial T705 NVMe M.2 SSD. This supports PCIe 5.0, allowing it to deliver sustained reading at 14,410MB/sec, but writing is below the Samsung drives elsewhere at 10,289MB/sec in CrystalDiskMark 9.0.1.

Despite being the cheapest CPU in this test, the AMD Ryzen 9 9950X still managed a credible 840 in our Media Benchmarks, with a particularly impressive 385 in the image-editing workload. It also did well in Maxon Cinebench 2024 for its core count, managing 2,435 in the multicore portion. This was accompanied by a solid Blender Gooseberry CPU render time of 4mins 3secs.

The SPECworkstation 4.0 verticals were more mediocre, and while SPECviewperf 15 Creo and SolidWorks CAD scores were better than GeForce RTX 5090-powered systems, overall this system's Nvidia RTX 4000 Ada Generation was behind most entrants.

Coming in at under £3,000 exc VAT the Workstation Specialists WS AR-X8700 was always going to be at a disadvantage to systems that used more of the £5,500 budget for performance components. If your budget is at this level and you're a CAD designer, however, it's still worth considering.

Will Intel ever be back in the workstation market?

Certainly not this year. But there are promising signs for next year, if Intel hits all its claims – and assuming AMD doesn't jump ahead once more

It feels like a broken record to be discussing how far ahead AMD is with workstation CPUs. We've been riffing around this topic since the AMD Ryzen Threadripper appeared in 2018. By 2019 AMD CPUs were already dominating the higher-end price point, and this hasn't changed since. With just one uncompetitive Intel Xeon on display this month, we need to ask what it will take to return Intel to its dominant ways of the past.

The controversy surrounding 13th and 14th gen Intel Core CPUs hasn't helped Intel's progress. These CPUs experienced elevated operating voltages and thermal management challenges, which could lead to degradation and eventual failure. Intel did fix this with microcode updates, but not without an impact on performance.

The 15th gen Intel Core arrived in mobile form in 2023, and with it a brand change to Core Ultra. It was the first mainstream Intel microarchitecture chip to use a disaggregated multi-chip module (MCM) design, which AMD has been using for its Zen architecture since 2017. This allows different functions of the processor package to be separated into different "tiles" (or "chiplets" in AMD language), such as the memory controller, I/O and integrated graphics.

MCM designs allow CPUs with different core counts to be made up of different numbers of compute tiles, but unlike AMD Intel hasn't taken this route yet with its desktop CPUs. New functions, such as the neural processing unit (NPU), are also now being added to "AI" chips from both AMD and Intel via an additional tile.

Slow progress

While the first Intel Core Ultra CPUs were mobile-only, Series 2 does have desktop variants. These top out with the Intel Core Ultra 9 285K. However, this still lags behind the AMD Ryzen 9 9950X and 9950X3D in multithreaded tests, even if single-core performance is a little better. Overall, the 285K offers similar performance to the best Ryzen 9 9000 series CPUs, but it does so by consuming more power. It won't be the Intel processor design that returns the company to the top rung.

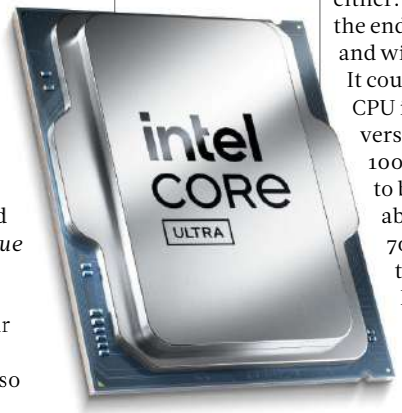
Maybe Core 9 Series 3, due in the second half of 2025 but not in volume until 2026, will pose more of a challenge to AMD. This will have a considerable die shrink by using 2nm production, instead of the 3nm of Series 2. The "P" performance cores, codenamed Cougar Cove, will allegedly have a 30-40% single-threaded performance boost and up to 20% for multithreaded software compared to the Series 2's Lion Cove. If that materialises, Intel may pose a threat again on the desktop.

ABOVE **Only one of the systems on test this month ships with an Intel processor**

However, professional workstation CPUs lag behind consumer ones. It's been a year since the Zen 5-based AMD Ryzen 9 9000-series graced our Labs, and now we finally have the Threadripper version (although server-oriented AMD EPYC processors based on Zen 5 have been available since the beginning of Q4 2024). This includes the Zen 5c versions, which use a 3nm process and offer up to 192 cores on a single CPU.

Intel has been using an MCM design in its Xeon processors since Sapphire Rapids, the fourth generation of Xeon Scalable, which is the architecture of Intel w3, w5, w7 and w9 workstation CPUs. The Lenovo ThinkStation P5 Tower in this month's test uses a processor from this generation, and we reviewed the W-2500 last year (*see issue 363, p52*). However, they're derived from 12th gen Intel Core CPUs so lag behind their mainstream desktop equivalents. The cores are also manufactured using a 7nm process, rather than the 4nm of AMD's 9000-series Ryzen and Ryzen Threadripper.

There are good signs – but AMD's processor designs won't stand still either. Intel has its work cut out keeping up



BELOW **Core Ultra chips consume more power than AMD's Ryzen 9 9000 series**

Promising signs

The Sapphire Rapids-WS workstation Xeons are a step in the right direction, with core counts of up to 60 per CPU. But both base and boost clock frequencies are lower than current AMD Ryzen Threadripper CPUs, making the Intel option less competitive than it could be, particularly in terms of performance per watt.

One option is to deploy multiple processors in a single system, which is where Intel Xeon Scalable processors come in. The 5th gen arrived at the end of 2023, but only in server guise. Even when a workstation version does arrive, it will still be a CPU with cores produced using a 7nm production process. The 6th gen (Granite Rapids) was launched at the end of 2024, alongside a rebrand to Xeon 6. This enables up to 128 cores per processor and uses a Redwood Cove design with a 3nm production process, bringing it more in line with current Intel desktop CPUs. This also makes it more promising if a workstation version arrives any time soon. We also know that the Xeon 7, aka Diamond Rapids, will arrive next year with a new generation of P-cores and Intel's radical 18A process node.

So there are good signs – but AMD's processor designs won't stand still either. The company's Zen 6 is due at the end of 2026 or beginning of 2027 and will use a 3nm or 2nm process. It could offer up to 256 cores per CPU in AMD EPYC form. The Ryzen version, expected to be called the 10000 Series, is already rumoured to be targeting clock speeds well above 6GHz and promises up to 70% better performance than the previous 9000 generation. Intel has its work cut out keeping up, and it remains to be seen if it will in the workstation market.

ARMARI MAGNETAR MC64T9

A hugely potent package showcasing the latest Ryzen Threadripper and flagship RTX professional graphics

SCORE ★★★★★
PRICE £10,995 (£13,194 inc VAT)
from armari.com

Armari was one of three manufacturers that managed to get hold of an AMD Ryzen Threadripper 9000-series processor in time for this test. It's also gone in with all guns blazing with its graphics acceleration. The result is a system that beats almost every other system this month and grabs one particularly noteworthy benchmarking record.

Unlike Scan's top-end system, Armari has chosen the 32-core (64-thread) Ryzen 9970X for the Magnetar MC64T9. Although the base clock of 4GHz is the same as the old 7970X, the boost is now 5.4GHz instead of 5.3GHz. With a 4nm manufacturing process instead of 5nm, it should be possible to run more cores at a faster frequency at the same time. To ensure this, Armari supplied its own custom 360mm water cooling for the CPU.

There's plenty of memory, too. The 256GB of 6,400MHz DDR5 memory, supplied as four 64GB modules, takes up all four DIMM slots on the Asus Pro motherboard, but you probably won't need more. You also get the full benefit from the Threadripper's quad-channel memory configuration.

Armari has left no expense spared with the graphics acceleration, either. The Nvidia RTX Pro 6000 Blackwell is a hugely expensive GPU costing nearly £8,000, but that's reflected in its dominance: it offers a staggering 24,064 CUDA cores and 96GB GDDR7 memory with ECC and 1,792GB/sec bandwidth. Performance is boosted by native support for PCIe 5.0, the first Nvidia professional accelerator to offer this. Its four DisplayPort 2.1b connectors can also power four 4K screens at 120Hz or 5K ones at 60Hz.

For its higher-end systems Armari typically supplies its own custom-designed chassis, which are excellent. However, the company felt that the Antec Flux SE already excels at cooling, thanks to its high-quality fans – including one in the base pushing cold air upwards. There are mounting points for two 2.5in or 3.5in drives and one more for a 2.5in unit. Armari has also included a potent 1,650W Thermaltake GF3 Gold PSU to ensure the powerful GPU and CPU have plenty of power to draw upon.

Although just one storage device has been supplied, it's reasonably generous. The Samsung 9100 Pro Series NVMe M.2 drive provides 4TB and supports PCIe 5.0. The Samsung SSD delivered sustained reading at 14,737MB/sec and writing at 13,214MB/sec in CrystalDiskMark 9.0.1. There are a couple more M.2 slots on the motherboard if you need to add storage. The Asus motherboard also offers a pair of 40Gbits/sec USB-C 4 ports, so you can attach extremely fast external storage, too.

The AMD Ryzen Threadripper 9970X can't match the 64-core chip in Scan's top-end system this month for multithreaded performance, but in Armari's hands it reigned supreme in our Media Benchmarks. The score of 1,143 is the fastest we've ever seen, with a phenomenal video encoding score of 1,096 and multitasking at 1,440. With a multithreaded Maxon Cinebench 2024 result of 4,171 and Blender Gooseberry render time of 2mins 20secs, the Armari system is faster than Scan's system with the same CPU. Only a 64-core CPU is quicker, and not by so much if it's a 7000-series Threadripper. Looking at the SPECworkstation 4.0 results, this is a great system for AI/Machine Learning and Life Sciences too, although all Vertical results are competitive.

ABOVE The Armari system broke all records in the *PC Pro* Media Benchmarks

If you're doing 3D animation, CAD and product design, or any other visualisation task, this system will provide an extremely smooth workflow

The Nvidia RTX Pro Blackwell is unbeatable for 3D viewports, with the best or close to the best results in every SPECviewperf 15 test. If you're doing 3D animation, CAD and product design, or any other visualisation task, this system will provide an extremely smooth workflow and offers incredible GPU-powered processing of non-visualisation workloads, too.

The Armari Magnetar MC64T9 misses out on the top prize this month to Scan's incredible 64 cores for the same price. But this is still a great workstation, which will make short shrift of any task you throw at it.

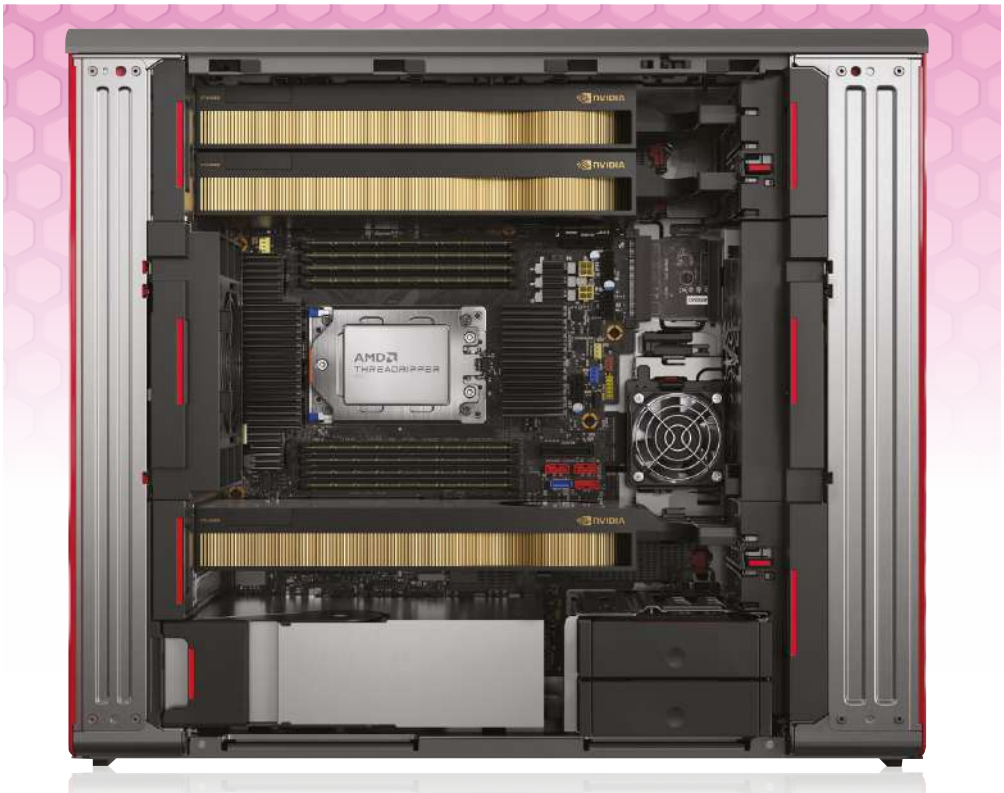
BELOW The Antec Flux chassis offers outstanding cooling

LENOVO THINKSTATION P8 TOWER

Not the fastest, but a great chassis design and capable performance for every content creation workload

SCORE ★★★★☆

PRICE £10,829 (£12,995 inc VAT)
from lenovo.com



When we've reviewed Lenovo workstations in the past we've always been impressed by the design. This "Aston Martin-inspired" ThinkStation P8 Tower is no exception. What is exceptional is how well Lenovo has matched up the specifications to the brief we provided for this group test – previous systems have been more off-the-shelf – with this P8 sitting close to our £11,000 exc VAT ceiling.

Our sample system does suffer from having the now previous-generation AMD Ryzen Threadripper Pro 7975WX CPU rather than the just-released 9975WX, but we're sure the latter will be made available once validated on this platform as BIOS compatibility should be all that is required. The 7975WX is a 32-core (64-thread) CPU with a 4GHz base clock and 5.3GHz boost frequency.

This is no different to the non-Pro version, but it offers more PCIe 5.0 lanes and an eight-channel memory controller, which will benefit performance in some areas. To take advantage of this, Lenovo supplied the P8 with a massive 512GB of 4,800MHz ECC DDR5 memory. This came as eight 64GB DIMMs taking up all the slots, but will you ever need more?

Lenovo keeps things professional with the P8's graphics. Unlike the P5 on test this month, the P8 can be supplied with a range of AMD Radeon Pro accelerators too, but Lenovo chose the Nvidia RTX 5000 Ada Generation, which is a sensible option to balance this system out within the budget. This accelerator offers 12,800 CUDA cores and 32GB of GDDR6 frame buffer providing 576GB/sec throughput. These figures are dwarfed by the RTX Pro 6000 Blackwell's capabilities, but it remains a strong high-end professional 3D card.

We always love the tool-free design of Lenovo workstations, and the P8 combines this with those attractive Aston Martin-inspired looks. We're not sure whether the British sports-car manufacturer would ever have made anything as blocky as a PC chassis, but we still like the P8's appearance. We also appreciate how compact it is, yet you can still install two graphics cards, up to three NVMe M.2 drives, a front-accessible M.2 drive, and even up to two 15TB U3 drives or two 3.5in mechanical hard disks. A built-in media card reader is another option, which could be useful if you need to access digital images or video from flash memory. Our system also came with an Nvidia Mellanox ConnectX-6 dual-port 25Gb Ethernet adapter, for super-fast networking.

The pair of 2TB Kioxia XG8 NVMe M.2 drives are less cutting edge, being PCIe 4.0 drives rather than the PCIe 5.0 options we see elsewhere this month. With CrystalDiskMark 9.0.1, one delivered sustained reading at 7,003MB/sec and writing at 6,019MB/sec reading, while the other recorded an unsurprisingly similar 7,003MB/sec and 6,034MB/sec respectively. You can ask for multiple drives to be configured as a RAID as part of the ordering process, too; our sample had one for the operating system and software with the other for data.

The Threadripper Pro didn't give the P8 any performance advantage in the *PC Pro* Media Benchmarks. The overall score of 874 is about what we expect for a 32-core 7000-series AMD CPU. The Maxon Cinebench 2024 multicore result of 3,372 is more competitive, with the Blender Gooseberry CPU render taking just 2mins 45secs. The Verticals results with SPECworkstation 4.0 are mixed. The AI/Machine Learning result of 3.11 is decent, as are 4.28 in Life Sciences and 3.12 in Product Design, with an excellent 4.75 in Energy. But Media & Entertainment is less impressive at 3.55.

ABOVE The design of Lenovo's ThinkStation P8 is inspired by Aston Martin cars

What is exceptional is how well Lenovo has matched up the specifications to the brief we provided for this group test

The Nvidia RTX 5000 Ada Generation can't keep up with the Blackwell cards this month with SPECviewperf 15 animation viewsets, such as those for 3ds max, Blender and Maya. But Creo and SolidWorks CAD and product design are competitive, all of which makes it clear where the P8 Tower's talents lie.

BELOW The case's tool-free design makes access easy

Overall, this is a very credible workstation from Lenovo. We usually expect blue-chip manufacturers to charge significantly more than their UK counterparts due to their brand reputation, custom design and additional services, but the Lenovo ThinkStation P8 Tower provides plenty of performance and features for the money. If you want the reassurance of one of the most famous computer manufacturers in the world, this is a capable machine.

PCSPECIALIST FORTIS GOLIATH R

A pro-grade specification, but the stiff competition this month keeps it away from the prizes

SCORE ★★★★☆

PRICE £10,800 (£12,960 inc VAT)
from pcspecialist.co.uk

British manufacturer PCSpecialist has gone fully professional with its high-end system this month. Not only does the Fortis Goliath R incorporate pro-grade graphics acceleration, it also uses the Pro version of AMD's Ryzen Threadripper. This is a system that means business as a content creation workhorse.

The Fortis Goliath R doesn't go for the very top of the Threadripper Pro range, instead opting for the 32-core (64-thread) 7975WX. This runs at a base 4GHz with a 5.3GHz boost clock. This will soon be replaced by the 9975WX in AMD's range, but we expect that to be more expensive than the outgoing 7975WX.

PCSpecialist has chosen the Threadripper Pro because it supports eight-channel memory, where the non-Pro version is quad-channel only. Taking advantage of this, the Goliath R has eight 32GB modules of 4,800MHz ECC Registered memory, for a total of 256GB. This fills all the DIMM slots on the Asus Pro WS WRX90E Sage SE motherboard, so all eight modules would need to be replaced for upgrade, but 256GB will be enough for the foreseeable future.

Surprisingly, the Goliath R doesn't use the latest Nvidia RTX Pro 6000 Blackwell, but the previous RTX 6000 Ada Generation. That's over £1,000 cheaper, however, and still a very potent accelerator. It's behind the Blackwell cards in technology, including lacking PCIe 5.0 support, but it offers 18,176 CUDA cores and 48GB of GDDR6 frame buffer providing 960GB/sec throughput.

Like its cheaper system, PCSpecialist sticks with the Fractal Define 7 for the Fortis Goliath R's chassis, but in this case (see what we did there?) it's the larger XL Black variant. This is taller and deeper but the same width as the non-XL. It offers eight 2.5in/3.5in drive mount locations and optionally up to 18, with two 2.5in mounts plus up to five if required. Surprisingly, though, only an 850W PSU has been included. We would have expected as much as twice that for the components included in this system.

There's a lot of potential for storage, but the Fortis Goliath R instead relies entirely on M.2 NVMe drives. Two Samsung 9100 Pro Series PCIe 5.0 SSDs are supplied – a 1TB model for running the OS and applications, and a 2TB one for data. This seems meagre for the price, but the performance isn't. Running CrystalDiskMark 9.0.1, the 1TB drive delivered sustained reading at 14,729MB/sec and writing at 13,194MB/sec, while the 2TB drive managed 14,722MB/sec and 13,558MB/sec respectively.

Although the Fortis Goliath R has a strong array of professional components, in this month's company it's merely middling. The overall *PC Pro* Media Benchmark score of 776 is behind most other systems, let down particularly by the video encoding result of 591. The Maxon Cinebench 2025 multicore result of 3,414 is about par for this processor, however, and the Gooseberry Blender CPU render time of 2mins 39secs is above average. All the scores in the SPECviewperf 4.0 verticals are higher than the other system with this processor, the Lenovo ThinkStation P8 Tower. The Life Sciences and Product Design scores of 4.84 and 3.55 respectively are particularly promising.

ABOVE PCSpecialist's Fortis Goliath R offers professional-grade graphics acceleration

The PCSpecialist Fortis Goliath R is a capable workstation with a good balance between modelling and rendering power

The SPECviewperf 15 results are solidly above the Nvidia RTX 4000 and 5000 Ada Generation accelerators in other systems this month, as you'd hope for the 6000. The maya-07 result of 295.02 is a highlight, with a solid score of 113.25 in 3dsmax-08, showing decent 3D modelling and animation abilities. The professional graphics accelerator also doesn't suffer from the CAD performance limitations of the consumer-grade graphics this month. However, the Nvidia RTX Pro 6000 Blackwells in other systems are a rung above in every respect.

BELOW The Fractal Define 7 chassis offers up to 18 drive mounts

The PCSpecialist Fortis Goliath R is a capable workstation with a good balance between modelling and rendering power. However, it's up against some stiff competition from systems with the latest components, putting it out of award contention in the £11,000 exc VAT category.

SCAN 3XS GWP-A1-TR64

An outstanding workstation thanks to its incredible speed, topping the table in almost every area

SCORE ★★★★★
PRICE £11,000 (£13,200 inc VAT)
from scan.co.uk/3xs

Scan was one of two manufacturers to grab early samples of the new 9000-series AMD Ryzen Threadripper, equipping the 3XS GWP-A1-TR64 with the top-tier 64-core version. In fact, this system has no holds barred in any area.

Let's start with that CPU. The non-Pro Threadripper tops out with the 9980X, which offers 64 cores (128 threads) running at a base 3.2GHz but with a 5.4GHz boost clock. This is one of the differences compared to the previous 7980X, which maxes out at 5.1GHz. However, the new CPU's 4nm process should mean more cores can run at a higher speed more of the time.

Scan backs this with 128GB of 5,600MHz DDR5 memory, supplied as four 32GB DIMMs. This will be enough for now, but 256GB would be more future-proofed, and you'd need to replace all the modules to achieve this as there are only four DIMM slots on the Asus motherboard. At least you get the full benefit of the Threadripper's quad-channel memory bandwidth – and you can always ask for an upgrade at the time of purchase.

The GPU choice is as range-topping as the processor. Like the 9000-series Threadripper, Blackwell versions of Nvidia's professional RTX accelerators have only just started to arrive, and the only one currently available is the RTX Pro 6000 Blackwell, as used here. This is currently Nvidia's most powerful accelerator outside of its AI-focused products for data centres, offering an unprecedented 24,064 CUDA cores and 96GB of GDDR7 memory with ECC and 1,792GB/sec bandwidth. This is also the first professional Nvidia accelerator to natively support PCIe 5.0. It can drive up to four 4K screens at 120Hz through its quartet of DisplayPort 2.1b connections. Truly, a monster GPU that's priced close to £8,000 inc VAT.

These potent components are housed in an imposing Fractal North XL Charcoal Black chassis. With its dark wood slats at the front, this gives off a Nordic furniture vibe but feels much sturdier than a flatpack cabinet.

It has mounts for two 3.5in or 2.5in and two further 2.5in only drives, plus a collection of useful USB and audio ports on the top at the front.

The motherboard offers three M.2 slots so you might want to use those USB ports to add storage instead. Scan equips the 3XS GWP-A1-TR64 with a single 4TB Samsung 9100 Pro Series NVMe drive supporting PCIe 5.0. It's a popular choice this month, and we can see why: it delivered superfast sustained reading at 14,766MB/sec and writing at 13,402MB/sec, so loading apps is decidedly breezy.

With its potent core components, the 3XS GWP-A1-TR64 was always going to do well in our performance tests. There are two quicker systems in our Media Benchmarks, because the applications this uses make only some use of multithreading, and the Threadripper 9980X operates its cores at a lower clock than the 32-core 9970X variant. But a result of 973 is still phenomenal, with 1,348 in multitasking a highlight. The Cinebench 2024 multicore result of 6,303 is the fastest we've ever seen, mirrored by a CPU rendering time of only 1min 32secs seconds in our Blender Gooseberry test. Other than the Wired2Fire, this leaves other workstations trailing in the distance.

ABOVE The Scan system topped the charts in almost every benchmark test

The Nvidia RTX Pro 6000 Blackwell graphics excelled across the board with SPECviewperf 15 but showed particular strength in CAD, with a creo-04 result of 280.14 and 249.99 in solidworks-08. This was the fastest system in the AI/Machine Learning vertical of SPECworkstation 4.0 with 4.16, and top in Life Sciences with 6.56, although this system was fastest in every vertical of this test.

With the list price of the CPU and GPU together close to the full cost of this system, it's gobsmacking that Scan has been able to fit both in

With the list price of the CPU and GPU together already close to the full cost of this system, it's gobsmacking that Scan has been able to fit both in. This is perhaps testament to the buying power of an organisation as big as Scan. This potent combo meant it was impossible for us not to make the 3XS GWP-A1-TR64 the Labs Winner this month. Apart from some more clock-sensitive workloads, it reigns supreme in every category of CPU or graphics performance.

BELOW Wooden slats on the front give off a Nordic furniture vibe

WIRED2FIRE TRX50 EXTREME 5090 WORKSTATION

A strong spec for the money, especially as it will benefit from a free upgrade to the Threadripper 9980X

SCORE ★★★★☆

PRICE £8,333 (£10,000 inc VAT) **from** wired2fire.co.uk

Wired2Fire is a new name in our workstation Labs test, but from this first foray we expect to be seeing the Surrey-based company more often. The TRX50 Extreme 5090 is a potent combination of components that offers many strengths for content creation tasks.

Central to the TRX50 is its Ryzen Threadripper 7980X processor, a 64-core (128-thread) CPU with a base 3.2GHz clock and 5.1GHz boost mode. Wired2Fire has confirmed that this system will be supplied with the Threadripper 9980X for the same price (*see p85 for a side-by-side comparison in select benchmarks*).

Wired2Fire supplies 256GB of 5,600MHz DDR5 memory as four 64GB modules, taking advantage of the CPU's quad-channel bandwidth. These take up all four DIMM slots on the Asus Pro WS TRX50 Sage WiFi motherboard, but 256GB is plenty.

Unlike other manufacturers with entries in the higher-priced category, Wired2Fire has chosen consumer-grade graphics. But while this loses a little for some types of workload, it's a sensible price compromise for most workloads and anything benefiting from GPU acceleration. This is particularly true when the graphics are an Nvidia-powered Asus ROG Astral LC GeForce RTX 5090. This Blackwell generation card packs 21,760 CUDA cores and 32GB of GDDR7 memory with 1,792GB/sec bandwidth. It supports PCIe 5.0 too.

Wired2Fire has opted for an Antec chassis. The Flux Pro is a little longer and taller than the SE version used by Armari but otherwise looks very similar. It's an excellent chassis, with room for a 420mm radiator at the front or top and fans at the top and bottom to bring cold air in and send it out the top and back in a natural flow. There's a reassuringly powerful PSU included as well – a Be Quiet! Dark Power Pro 13 rated at 1,600W.

You get plenty of options for drives, too, with four 3.5in/2.5in mounts plus two for 2.5in drives only. The TRX50 comes with one NVMe M.2 SSD to start with. However, it's a rapid and capacious 4TB Samsung 9100 Pro Series with a PCIe 5.0 interface. Using CrystalDiskMark 9.0.1, it delivered sustained reading at 14,704MB/sec and writing at 13,399MB/sec. You can add a couple more M.2 drives or a U.2 drive for more fast storage.

With 64 cores, the TRX50 was always going to be a leading performer, even if it's a 7000-series Threadripper rather than the latest 9000-series. The overall score in the *PC Pro* Media Benchmarks of 897 is very good, and the video-encoding result of 848 one of the best this month – but this still isn't where this CPU excels most. The Maxon Cinebench 2024 multicore result of 4,696 is more revealing, albeit significantly behind the 9980X provided by Scan this month. Taking only 1min 40secs to complete the Blender Gooseberry CPU render, this system is a demon for 3D final output.

This workstation's SPECworkstation 4.0 vertical results don't reflect the huge number of cores packed inside. The Financial Services Vertical is the highlight, even if doesn't fall within our focus of content creation workloads. Media & Entertainment is also very good, however, which does.

ABOVE **Wired2Fire's first appearance in our workstation Labs is an impressive one**

While the TRX50 isn't optimal for CAD visualisation, it will be brilliant for 3D animation and output for movies, TV and games

The SPECviewperf 15 scores show the usual strengths and weaknesses of consumer-grade graphics. A 3dsmax-08 result of 140.51 and maya-07 score of 338.34 imply excellent performance when 3D modelling for animation or gaming. But with 134.88 in creo-04, it's behind professional Nvidia RTX cards for CAD and product design, and 61 in solidworks-08 is very slow. For some reason, the system wouldn't complete the Chaos Enscape workload either.

BELOW **The Antec Flux Pro case is well designed for cooling**

While the Wired2Fire TRX50 isn't optimal for CAD visualisation, it will be brilliant for 3D animation and output for movies, TV and games. It's also priced nearly £2,700 exc VAT under our £11,000 budget. This is still a lot of money, but you get plenty of workstation performance for your pounds, and you'll get even more with the promised Threadripper 9000-series upgrade.

View from the Labs

If you're a creative pro and you're not experimenting with GenAI, you may find yourself left behind

The rise of Generative AI (GenAI) has been even more rapid than the internet's, but up until this point the biggest GenAI buzz has surrounded online services. Whether you use ChatGPT or video GenAI such as Sora, you enter a prompt via a web interface and download the results from there, too. Your local hardware has been irrelevant.

You might think that recent Adobe innovations such as Firefly, Generative Fill in Photoshop and Generative Extend in Premiere Pro do some of their processing on your workstation, because they're integrated into software that runs locally. However, they need online connectivity to work, and most of the heavy processing is still running remotely. The sole exception is AI audio enhancement in Premiere Pro, which does run locally and doesn't require an internet connection.

But it is possible to run a wider variety of GenAI workloads on your own system. You can install an interface such as LM Studio or GPT4All for text-based GenAI and then download a local LLM such as Llama 2 or Mistral 7B Base Model. Queries will then be processed on your desktop hardware. However, the model used is then essentially static until you download an updated version, whereas an online LLM can be regularly updated without the user having to do anything – they just use the same web interface.

James Morris is a former editor of *PC Pro* and always toying with cutting-edge hardware

You can also run creative GenAI such as Stable Diffusion locally, although getting this up and running is not for the non-technical. It's also worth noting that LLMs can be very large, particularly image-based models. Stable Diffusion models can be anywhere from 2GB to 8GB each, and you may want more than one for different styles. Some users have 10TB models. On the plus side, running GenAI like this locally means you won't contend with other users to get results, so output can be faster. This is where having a speedy workstation – particularly with a powerful GPU – can help.

I fully expect more creative functions to move from the cloud to the workstation as local AI processing power increases

The SPECworkstation 4.0 benchmark suite we introduced into this year's Labs test does include some real locally running AI workloads. It simulates a data scientist's workflow, including tasks such as data scrubbing, ETL (extract, transform, load) and classical machine learning operations, using popular tools and libraries such as NumPy, Pandas, Scikit-learn and XGBoost. It also measures Open Neural Network Exchange (ONNX) inference for machine learning, covering different levels of precision, including FP32, FP16 and INT8. The Accelerator Hardware Subsystem shows more synthetic AI/ML potential, particularly from the GPU.

So, for those creatives who have ignored GenAI up until now, I have a simple message: it's here now and here to stay. If you don't incorporate it into your creative workflow to improve productivity you could be left behind by those who do. For the time being, though, this will still mostly be via cloud-based services rather than running locally.

However, that caveat of "for the time being" is crucial. Scientific researchers and data scientists are already harnessing local power for building their own machine learning models. I fully expect more creative functions to move from the cloud to the workstation to improve performance as local AI processing power increases. This is why it's time to start thinking about how well your content creation workstation can run AI workloads today, in anticipation of what could be a very near GenAI future. ●

PC Pro Media Benchmarks

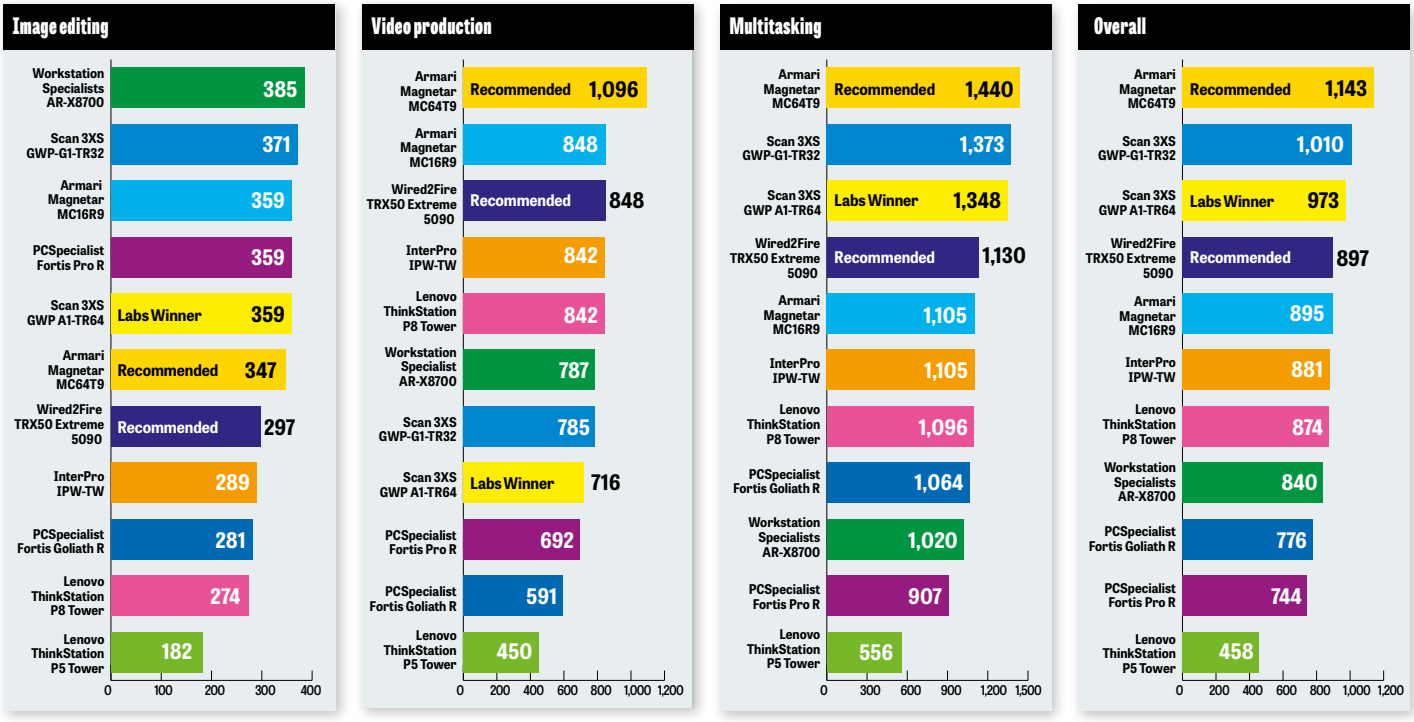


Image editing
Workstation Specialists AR-X8700 385
Scan 3XS GWP-G1-TR32 371
Armari Magnetar MC16R9 359
PCSpecialist Fortis Pro R 359
Scan 3XS GWP A1-TR64 Labs Winner 359
Armari Magnetar MC64T9 Recommended 347
Wired2Fire TRX50 Extreme 5090 Recommended 297
InterPro IPW-TW 289
PCSpecialist Fortis Goliath R 281
Lenovo ThinkStation P8 Tower 274
Lenovo ThinkStation P5 Tower 182
0 100 200 300 400
Video production
Armari Magnetar MC64T9 Recommended 1,096
Armari Magnetar MC16R9 848
Wired2Fire TRX50 Extreme 5090 Recommended 848
InterPro IPW-TW 842
Lenovo ThinkStation P8 Tower 842
Workstation Specialist AR-X8700 787
Scan 3XS GWP-G1-TR32 785
Scan 3XS GWP A1-TR64 Labs Winner 716
PCSpecialist Fortis Pro R 692
PCSpecialist Fortis Goliath R 591
Lenovo ThinkStation P5 Tower 450
0 200 400 600 800 1,000 1,200
Multitasking
Armari Magnetar MC64T9 Recommended 1,440
Scan 3XS GWP-G1-TR32 1,373
Scan 3XS GWP A1-TR64 Labs Winner 1,348
Wired2Fire TRX50 Extreme 5090 Recommended 1,130
Armari Magnetar MC16R9 1,105
InterPro IPW-TW 1,105
Lenovo ThinkStation P8 Tower 1,096
PCSpecialist Fortis Goliath R 1,064
Workstation Specialists AR-X8700 1,020
PCSpecialist Fortis Pro R 907
Lenovo ThinkStation P5 Tower 556
0 300 600 900 1,200 1,500
Overall
Armari Magnetar MC64T9 Recommended 1,143
Scan 3XS GWP-G1-TR32 1,010
Scan 3XS GWP A1-TR64 Labs Winner 973
Wired2Fire TRX50 Extreme 5090 Recommended 897
Armari Magnetar MC16R9 895
InterPro IPW-TW 881
Lenovo ThinkStation P8 Tower 874
Workstation Specialists AR-X8700 840
PCSpecialist Fortis Goliath R 776
PCSpecialist Fortis Pro R 744
Lenovo ThinkStation P5 Tower 458
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Buyer's guide

Remote support software 2025

Give your IT support teams the tools they need in the hybrid working era, says **Dave Mitchell**, who puts four of the leading contenders through their paces

IT support teams are essential for efficient business operations, and no company would survive long without them. Flexible and hybrid working practises bring new challenges, though, as technicians are expected to provide fast and effective support no matter where staff are working from.

Telephone support can be inefficient and frustrating as it's often impossible to fix a problem without having access to the user's device. It's also far too expensive and time-consuming for technicians to personally visit users every time they have a hardware or software issue.

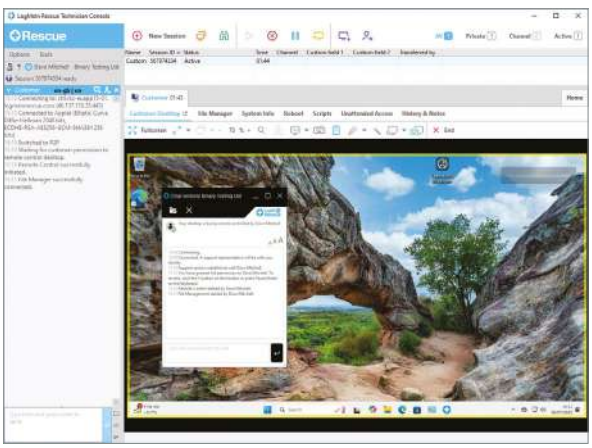
Remote support software is the perfect solution as it puts staff in front of the user's workstation without having to be physically present. Even better, cloud-hosted products allow them to diagnose and fix problems from the comfort of their own desk, even if they're also working remotely or at home.

Flexible working is driving an unprecedented demand for remote support products, and intense competition has forced prices down making them highly affordable for SMBs – and even those with a support department of one. In this month's guide we look at cloud-hosted support solutions from four of the big names – LogMeIn, NetSupport, IDrive and Zoho – and help you choose the one that best fits your working practices.

Safe houses

Cloud-hosted remote support is ideal for businesses with a mix of office-based, mobile and home workers. They're simple to set up as they don't require a central management server and their subscription-based licensing makes it easy to control costs, with many offering substantial discounts if you sign up for longer periods, along with options to upgrade or downgrade as required.

"Before implementing a remote support solution, it's important to understand the associated security risks and mitigate them"



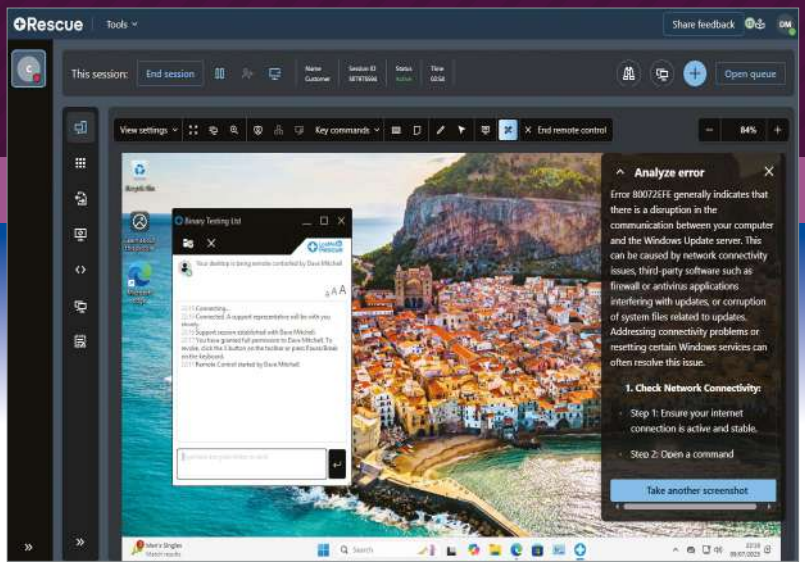
BELOW LogMeIn Rescue offers a Windows desktop client for technicians

Before implementing a remote support solution, it's important to understand the associated security risks and mitigate them. These products are capable of providing IT support staff with full access to remote systems and everything stored on them, so you should choose one that allows you to strictly control who has access to them.

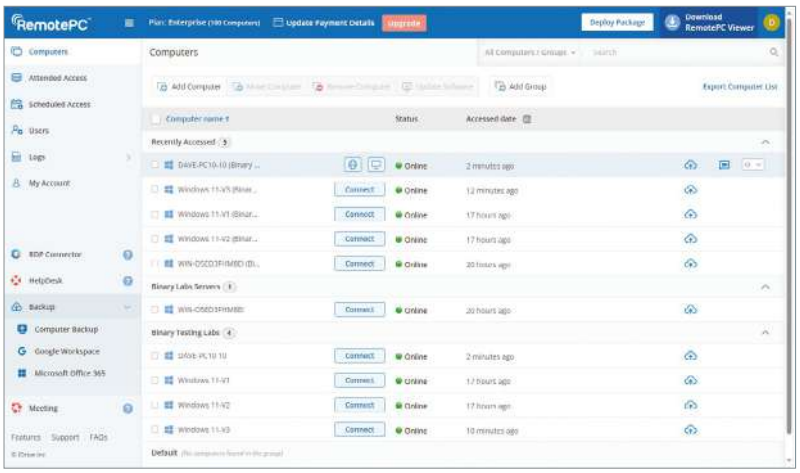
Avoid using multiple solutions as this makes it more difficult to manage security. Sticking with one product across your company makes it easier to maintain consistency and to train remote workers on how to use it.

It will also help your users recognise bogus support requests as scammers are increasingly using legitimate remote support software to gain access to a victim's computer. Most vendors are aware of this practice, with many blocking on-demand access in trial versions or warning users that the invitation may not be genuine.

Role-based administration is a valuable security feature. When


LogMeIn Rescue
Tools
Share feedback
This session:
End session
Open queue
End remote control
Analyze error
Error 80072EFE generally indicates that there is a disruption in the communication between your computer and the Windows Update server. This can be caused by network connectivity issues, third-party software such as firewall or antivirus applications interfering with updates, or corruption of system files related to updates. Addressing connectivity problems or resetting certain Windows services can often resolve this issue.
1. Check Network Connectivity:
Step 1: Ensure your internet connection is active and stable.
Step 2: Open a command
Take another screenshot

Binary Testing Ltd
dsvem@testing.com has invited you to join a remote support session. Upon joining, the technician will be able to view and access your computer.
Region: SUFFOLK, UNITED KINGDOM
Dave Mitchell would like access to your computer.
Access may be used to:
• Control or view your desktop
• View system information & Reboot
• Transfer, delete, overwrite or copy files
• Run scripts
• Invite technician for collaboration
This session may be recorded and static images of your screen may be captured. To protect your privacy, please close confidential information. To revoke all permissions, click the X button on the toolbar or press Pause/Break on the keyboard.
Only accept support from people you trust
This technician is using a free trial version of LogMeIn Rescue.
Report Abuse
Agree and Download
OK
Cancel



LEFT The AI module in LogMeIn Rescue can provide technicians with valuable help

ABOVE Good products will warn end users to verify the authenticity of support invitations

LEFT IDrive RemotePC includes attended and unattended access in one subscription

creating new technician accounts, you can decide what levels of access they are permitted to have. Device grouping is another useful feature: you can create groups, perhaps based on departments, and only allow specific technicians to support them.

Free remote access tools such as Chrome Remote Desktop and the Windows 11 Quick Assist apps should be avoided in a business environment, with the latter increasingly being used by threat actors to impersonate IT support staff. They're aimed primarily at personal use, have limited features and are almost impossible to manage and audit.

Attended and unattended

All remote support products require an agent to be loaded on client systems to allow the technician to access them. For on-demand access, the technician uses their web portal or personal console to send a request to the user with the message containing a unique session PIN and a download link for a temporary agent.

A session starts only once both sides have agreed to join and, on completion, the agent is removed automatically without trace from the remote system. An essential feature is the facility for end users to refuse a remote connection if they are unable to verify the identity of the person requesting it and terminate sessions from their desktop agent.

ABOVE Zoho Assist's technician console offers plenty of valuable support tools

All-hours access to unattended systems requires an agent to be loaded permanently, and all cloud-hosted products offer separate on-demand and unattended versions of their agents. For extra security, look for products that enforce password protection for unattended access and only allow the agent to be initially installed when an end user is present and can verify the requester's authenticity.

Check the vendor's licensing plans as well, since some include attended and unattended access in a single subscription while others offer them as separately licensed services. Discuss your requirements with the prospective vendor, too, as the best ones will offer volume discounts.

Take control

To improve the support experience, check what extra support tools are available. Along with the requisite remote control, these can include file transfer, audio, video and chat services, note taking, remote Registry editors and system inventory.

Session recording can create a video audit trail of support sessions, possibly for further analysis and training. Another handy tool is the facility for a technician to share their own screen with an end user to provide clearer visual guidance.

The main focus here is on Windows endpoints, but if you have a mix of devices check what other platforms they support as many offer agents for macOS, Android and Linux. You can't remotely control iOS devices due to Apple's strict security model, but most products provide apps for iOS mobile users to broadcast their screen contents during a session and control apps that allow technicians to access permitted systems and provide support on the move.

AI is making its way into remote support and has the potential to streamline support desk operations. One product in this guide offers an optional AI module with valuable time-saving features including session analysis, auto-generated session summaries, error code assistance and system health checks.

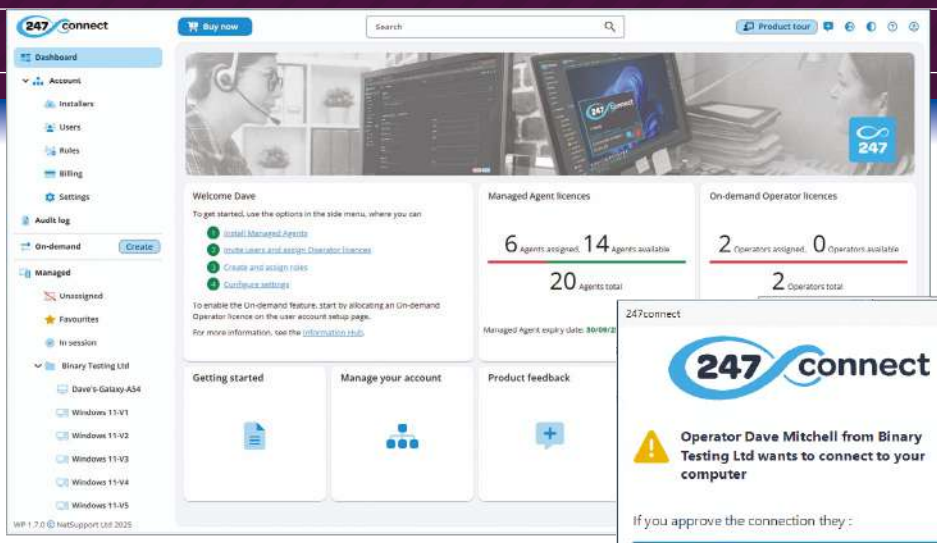
Cloud-hosted remote support can easily boost business productivity. We chose the four products for this guide as they're all available as free time-limited trials so you can try them out first. Along with tight access security, they offer a wealth of valuable features that will make your IT support department more agile and responsive – a problem solved quickly is a productivity gain.

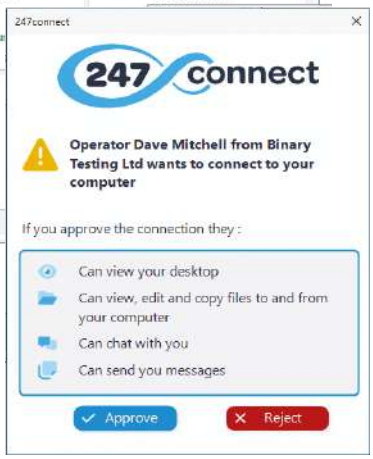
247connect

Still in development, but 247connect offers versatile cloud-hosted support with access security a priority

SCORE ★★★★☆

PRICE From £180 exc VAT per operator per year from 247connect.cloud




247connect
247connect
Operator Dave Mitchell from Binary Testing Ltd wants to connect to your computer
If you approve the connection they :
Can view your desktop
Can view, edit and copy files to and from your computer
Can chat with you
Can send you messages
Approve
Reject

It's for good reason that NetSupport's Manager has spent so long on the *PC Pro* A-List as it's simply the best on-premises remote support solution. The company has now decided it's time to move into the cloud-hosted support market, and in this review we take an early look at its new 247connect product.

It offers a flexible pricing structure split into two tiers. Costs for on-demand access are based on the number of operators, or technicians, starts at £180 per year and enables support for five concurrent connections.

Unattended access is priced per agent and starts at £4 each for up to 99, dropping to £2.50 for over 500. You can purchase either or both components, and a 14-day trial is available that doesn't require any credit card details.

The technician portal presents an overview of product licence status along with quick links to key deployment tasks. The left pane provides access to account settings, starting on-demand sessions and accessing unattended agents.

More technicians are added by sending them emails from the portal and choosing local, Google or Microsoft authentication. Roles lock down access security as you decide what support features each technician can access.

Three default roles are provided, with options to create custom roles and apply selected account, operator and on-demand permissions. 247connect employs a zero-trust philosophy so when new users are issued an on-demand licence, they don't have any access permissions until you assign them a role.

Before starting your first session, you download the Control app from the portal and install it on all technician systems, with deployment options including Microsoft InTune. Only the Windows installer was available to us, with versions for macOS and iOS coming soon.

On-demand sessions are started with one click. This loads a new window with a unique six-digit code and facilities to add a custom message, copy the web link and email it. Control is firmly in the end user's hands; when they click on the link, a web page opens with full details of the technician and company, sage advice on ensuring the request is from a trusted source and a button to download the runtime app, which loads another window that requests the session code.

The technician selects the system from their portal and chooses from the view, file transfer, chat or message options. Further permission is required from the user before the session can start, and the technician can also view a full inventory of the remote system's hardware.

ABOVE Unattended agents are organised into custom groups

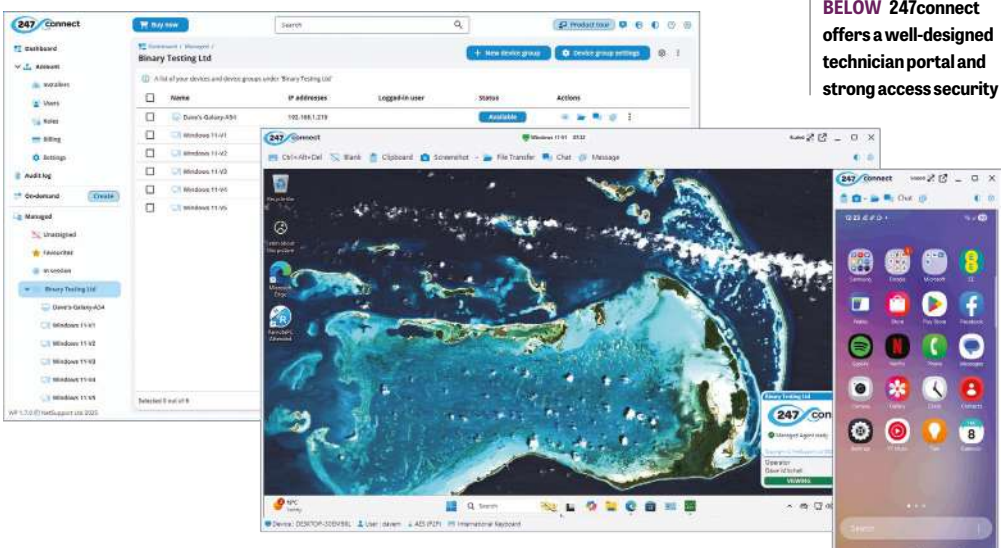
> **"247connect employs a zero-trust philosophy so new users don't have any access permissions until you assign them a role"**

The on-demand remote control screen presents a toolbar across the top for clipboard sharing, taking screenshots, chat and messaging, with the file-sharing tool loading a separate window for drag-and-drop copies. We were advised that PowerShell, a Registry editor, task manager and session-recording tools will be added to the interface soon.

Attended agents are currently available for Windows and Android devices, with one for macOS in development. The Windows agents can be manually installed or deployed with Group Policy Object, and we loaded the Android agent from Google Play and scanned the QR code in the portal to register the mobile with our account.

Zero trust comes into play again here as new unattended agents are placed in the "Unassigned" group and can only be accessed once they have been placed in a custom group or sub-group. From the roles assignment wizard, you can also decide which groups each technician is allowed to access.

247connect is still in development, but from what we've seen it offers a strong alternative to the established names. Its pricing plans are good value, it's easy to use, and its zero-trust foundation delivers strict access controls.



BELOW 247connect offers a well-designed technician portal and strong access security

REQUIREMENTS

Managed agent: Windows 10 • Server 2016 • Android 12 upwards. **Control:** Windows 10 • Server 2016 upwards

IDrive RemotePC Enterprise

Secure cloud-hosted remote support that's easy to use, very versatile and incredible value for larger businesses

SCORE ★★★★★

PRICE Enterprise, first year, 100 PCs, £329 exc VAT **from** remotepc.com

IDrive's cloud backup service has always been one of our top choices thanks to its features and value. RemotePC is equally rich in features and offers simplified licensing schemes based only on the number of endpoints you want to support.

Some products are licensed by concurrent technician sessions, but the three RemotePC business plans unleash support for unlimited users and include attended and unattended access. The Enterprise version has a first year cost of £329 for 100 PCs and enhances the Team plan with user roles, access permissions and computer grouping plus Microsoft Windows Group Policy Object and InTune support for mass deployments.

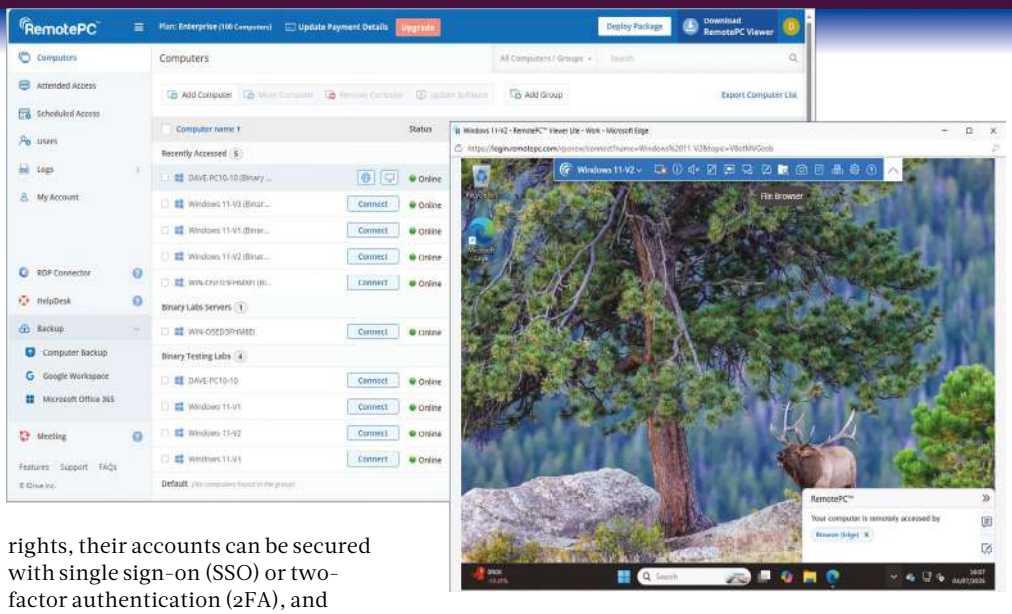
The Enterprise plan introduces scheduled remote access where sessions can be booked in advance. You also have redirection services for USB devices and microphones, multiple file-transfer support and quick-access desktop shortcuts.

The RemotePC web portal is nicely designed, and you start by creating more users, or technicians, and setting their access permissions. They can be given full administrative rights, their accounts can be secured with single sign-on (SSO) or two-factor authentication (2FA), and their level of access to each support feature can be determined.

Computer grouping strictly controls access to devices with the unattended agent installed. You can create as many groups as you want and assign technicians and teams so only they have access.

Technicians can use the web portal or the desktop RemotePC Viewer app, which is now available in the Microsoft Store. The app provides a simplified console for viewing all permitted computer groups and quickly creating attended and unattended support sessions.

Unattended access requires the RemotePC host app installed permanently on each device, and you use the web portal's Computers page to email a link to users with a download link. The app is customised for your account and, once loaded, the device appears in the web portal and Viewer app for one-click access, with the Enterprise edition allowing access security to be tightened further by optionally setting a personal code.



ABOVE RemotePC includes a desktop app as well as free iOS and Android mobile apps

PC PRO A-LIST

"Large businesses that want a flexible and feature-rich cloud-hosted support solution will love RemotePC Enterprise"

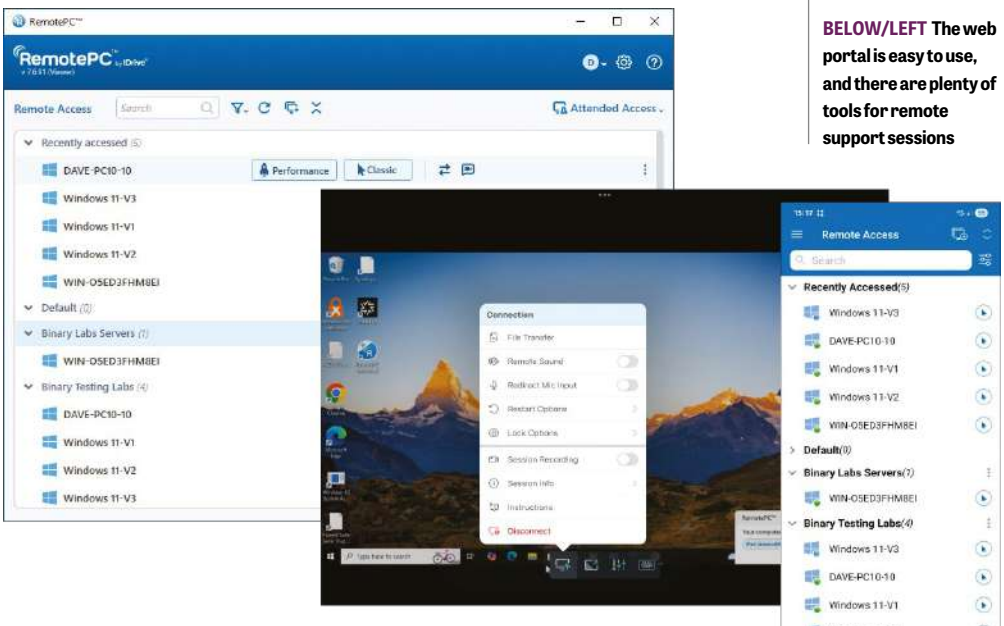
Sessions can be started directly from the portal with the Viewer Lite web app providing remote control, file browsing, upload and download services, text and video chat, snapshot and whiteboard services. Choose the desktop app if you want extra tools for bidirectional drag-and-drop file copying, remote printing and session recording.

There's more to the desktop app: its Performance Viewer connects to remote Windows hosts at up to 60fps, provides richer colour depth and presents a similar interface to Viewer Lite. The slower Classic interface is better for low-bandwidth connections and supports Windows, macOS and Linux hosts.

On-demand attended sessions are started by emailing an invitation to users from the web portal or desktop app with a link to the support URL. For added authenticity, the message can be customised, and when the user clicks on the download link a temporary app is loaded and the unique nine-digit session code it generates is shared with the technician.

IDrive provides helpdesk tools for queuing user requests and the Meeting feature for videoconferencing sessions with multiple participants. The portal and Viewer app even include access to IDrive's cloud backup service, with ten computers costing around £15 for the first year.

Large businesses that want a flexible and feature-rich cloud-hosted support solution will love RemotePC Enterprise. It provides technicians with a wealth of support tools, access security is tight, and IDrive's simple licensing plans are superb value.



BELOW/LEFT The web portal is easy to use, and there are plenty of tools for remote support sessions

REQUIREMENTS

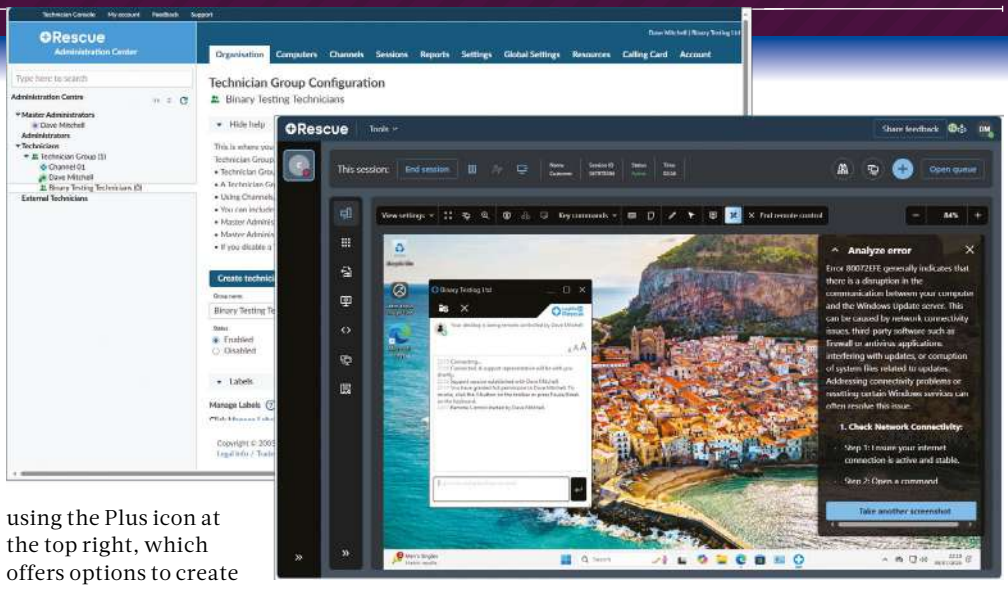
Windows 8/Server 2012 • macOS 10.11.6 • Android 7 • iOS 13, Chrome OS 7 upwards • Linux

LogMeIn Rescue

Great features and good value, LogMeIn is perfect for larger businesses that demand the best security

SCORE ★★★★½

PRICE From £71 exc VAT per month billed yearly from logmein.com



GoTo offers two distinct remote support solutions, and this year has brought them both under the same LogMeIn brand. LogMeIn Resolve targets IT professionals and MSPs, while LogMeIn Rescue on test here is aimed at businesses and enterprises seeking to support large numbers of users with the focus on access security.

Previously, Rescue comprised a cloud administration portal and separate technician desktop app, but moves are afoot to go web-first across the entire product. The desktop app is still provided but GoTo is developing a web portal so technicians can now choose between them.

The Rescue Administration Center portal is used to create master administrators that have full access to all settings, whereas standard administrators are allowed to manage groups of technicians. Security is very strict as you use groups to manage sets of technicians and decide precisely what support features they are allowed to access.

The new technician web portal can be run directly from the administration centre, where it displays a queue showing active and waiting on-demand support sessions. New sessions are created using the Plus icon at the top right, which offers options to create view-only and remote control connections along with mobile access if you've purchased the optional add-on.

After choosing a session, the portal generates a unique six-digit PIN and provides facilities to copy the link, email or SMS it. The remote user is warned if the technician is using a trial account and, when they accept the invitation, the Rescue runtime applet is downloaded and started.

When the technician starts the session, the user is asked again if they trust the connection and then their desktop appears in the web console. The web page provides a ribbon menu across the top for access to screen settings, a pointer, a whiteboard and key commands for starting apps such as the Task Manager, Control Panel and PowerShell.

More features are in the left menu bar, with the system inventory tab providing a wealth of information about the system's hardware. The file manager isn't currently available in the web interface but other options are provided for reboots, running scripts and pushing the unattended agent to the remote system.

ABOVE Technicians can run multiple supports sessions in the web console

PC PRO RECOMMENDED

"We started multiple sessions to our Windows 11 test clients and could swap between them with consummate ease"

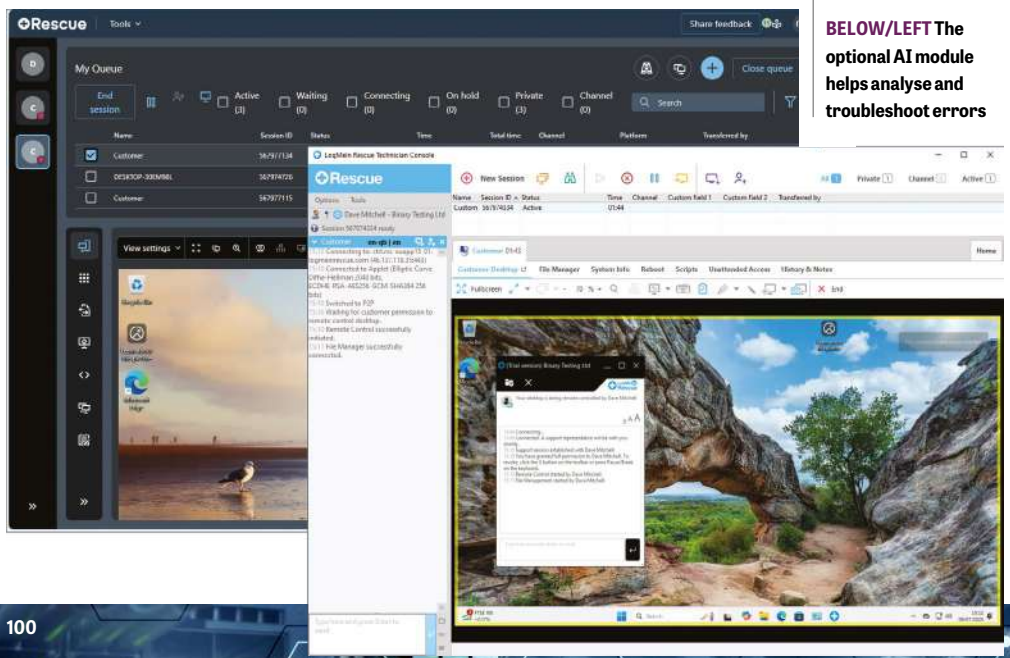
Technicians can have multiple sessions open and select them from the queue listing at the top of the web page. We started multiple sessions to our Windows 11 test clients and could swap between them with consummate ease.

The desktop app provides equally easy access for creating on-demand support sessions and employs exactly the same processes as the web portal. You can't have both open at the same time, but until the web portal is updated you'll need to use the app if you want to use the file manager.

For unattended access, you can customise the Windows, macOS and Linux apps from the admin centre, choose the technicians that can access them and apply an expiry date. Both the web portal and desktop app list all permitted systems, and connection is a swift two-click process.

There are plenty of upcoming features, with the optional AI module providing time-saving services such as session analysis, auto-generated session summaries, assistance with error codes, system health checks and more. The enhanced security module adds more checks, including device-based access restrictions and company PIN codes, while the translation module can be applied to chat sessions for global contact centre consolidation.

The new technician web console is a work in progress, but LogMeIn Rescue can't be faulted for its top-notch access security features. It offers a wealth of easily managed support tools and, although mobile support is optional, it does represent good value for money.



BELOW/LEFT The optional AI module helps analyse and troubleshoot errors

REQUIREMENTS

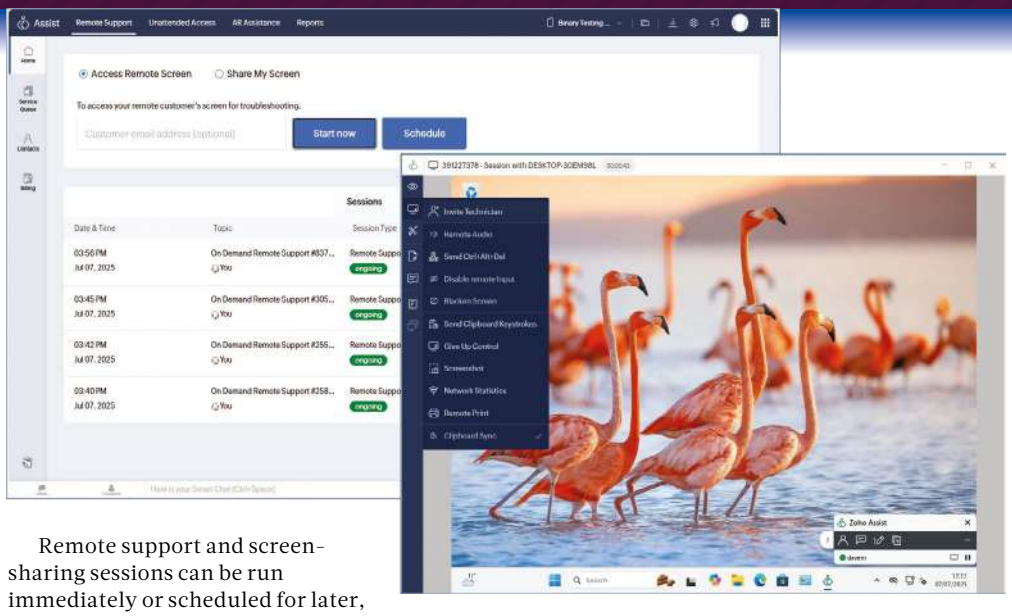
Technician/client: Windows 7/Server 2012 • macOS 10.13 • Android 5 • iOS 16 upwards • Linux

Zoho Assist Professional

Easily deployed cloud-hosted support with lots of features, tight access security and flexible licensing plans

SCORE ★★★★★

PRICE £12 per technician/month exc VAT (billed yearly) from zoho.com/assist



Zoho Corporation offers a huge range of business software tools covering everything from sales and marketing to security and IT management. The Assist cloud-hosted remote support solution has always been a key player in its portfolio and will appeal to companies of all sizes.

The free version supports one technician, one concurrent session and five unattended desktops. If you like what you see, Zoho offers three pay-as-you-go plans that can be upgraded, downgraded or cancelled at any time. The Professional plan on test provides all essential remote support features, supports four concurrent connections and has a monthly cost of £12 per technician when billed yearly.

Unattended access is a separate module with two pricing tiers. The Standard plan costs £8 a month for 25 unattended computers when billed yearly, while the Professional plan ups this to £12 and enables additional support for iOS and Android mobiles.

The technician's web console provides menu tabs for remote support and unattended access. The AR (augmented reality) Assistant tab comes into play if you've purchased the optional Lens add-on, which provides live camera streaming from remote iOS and Android mobiles.

Remote support and screen-sharing sessions can be run immediately or scheduled for later, and the portal generates a nine-digit code with options to copy the web link or email it. This downloads the Assist run-time app, asks the user to permit the session and warns them not to accept unsolicited invitations. For extra authenticity, technicians can create custom email templates.

Technicians have two options when connecting to remote systems, with the default web client being completely browser-based and requiring no installation. For faster responses there's the Windows native client app, which is made the default choice from your organisation's general settings page, and the first time a technician starts a session they're invited to download and install the app.

Both remote control clients provide plenty of support tools in pop-out sidebars. Technicians can open chat sessions, share their screen, invite other technicians to join in, run drag-and-drop file transfers, use the tools menu to access power controls, reboot the system, run scripts remotely and access all Windows management services.

Assist offers a wealth of unattended agent deployment options: you can use its own distributor agent or email links with custom messages and use Microsoft's Group Policy Object, Azure, SCCM or InTune. For smaller numbers of computers, you can individually add them to the portal from the dashboard, copy the link or email it directly to users.

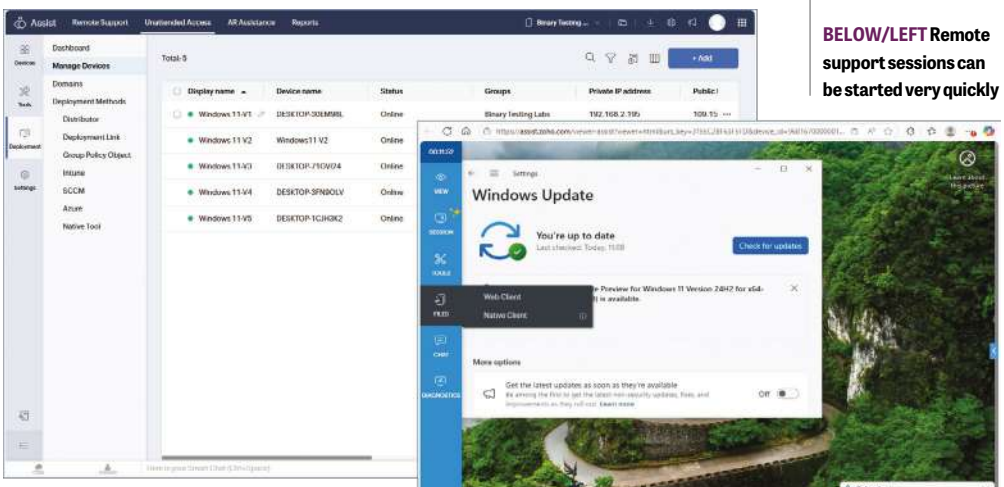
ABOVE Access to unattended systems is a one-click operation

It's worth setting up groups first as you can create custom deployment links that automatically place computers in the associated group. Assist supports static and dynamic groups, where the latter sorts computers by their device names, installed OS, domain name and manufacturer.

Unattended devices are available in the technician's portal for fast, one-click connections, or you can use the tools icon alongside to control the remote system and run file transfers without starting a full control session. A handy feature is the facility to view more details about the device directly from the portal. This includes a full list of all hardware, options to view and control running services, see installed software and run the Registry editor.

"Assist clearly lives up to its name as it's easy to use and manage, and it provides a wealth of support features"

Auditing services are excellent as the portal's reports section provides full session details, with the smart Geo Insights feature presenting a global map overview of all connections. Assist clearly lives up to its name as it's easy to use and manage, and it provides a wealth of support features, while Zoho's flexible licensing plans allows SMBs to carefully tailor it to their budgets.



BELOW/LEFT Remote support sessions can be started very quickly

REQUIREMENTS

Technician/client: Windows 7/Server 2012, macOS 10.9 • iOS 11 • Android 5, Chrome OS 16 upwards • Linux. **Windows native viewer:** Windows 10 upwards

Seagate 30TB IronWolf Pro & Exos M

Seagate delivers enormous hard disk capacities for a range of usage scenarios at very competitive prices

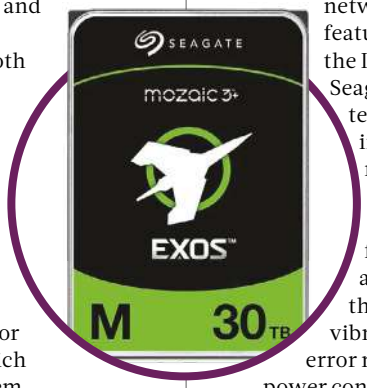
SCORE ★★★★½

PRICE IronWolf Pro, £449 exc VAT; Exos M, £424 exc VAT from broadbandbuyer.com

LEFT The IronWolf Pro drives come with a generous five-year warranty

Rapidly growing storage needs across the SMB and enterprise markets are driving intense competition between hard disk manufacturers as they strive to meet this demand. Seagate has stepped up to the plate with two monstrous 30TB hard disks and, in this review, we test both its IronWolf Pro and Exos M models.

A key feature of both SATA drives is that they're based on the well-established conventional magnetic recording (CMR) technology. This makes them fully compatible with just about any server, storage array or NAS appliance in which you care to install them.



Both models have ten platters, and Seagate has achieved an impressive 3TB per platter areal density in an industry-standard 3.5in form factor by implementing heat-assisted magnetic recording (HAMR). Part of its Mozaic 3+ technology architecture, HAMR uses laser diodes to heat minute spots on the recording media to make them more amenable to magnetic effects, allowing areal density to be increased significantly – Seagate's HAMR roadmap aims to deliver 4TB and 5TB per platter in the coming years.

They're aimed at distinctly different markets, with the IronWolf Pro targeting enterprise NAS applications, video production and network servers. A feature common across the IronWolf Pro family is Seagate's AgileArray technology, which increases reliability in multi-drive NAS appliances using a smart combination of firmware, hardware and software features that aims to reduce vibration, accelerate error recovery and control power consumption.

The IronWolf Pro drives are a great choice for businesses running mission-critical apps as they come with a generous five-year warranty as standard and include a three-year subscription to Seagate's rescue data recovery service. Once the drives have been registered, this enables instant access to Seagate's data recovery gurus, who will assist with data restoration in the event of accidental data corruption or a drive failure.

The Exos M is aimed at enterprise applications such as big data analytics, AI, hyperscale and cloud data centres. Along with HAMR, it gets the benefit of the full Mozaic 3+ technology portfolio and also includes Seagate's PowerChoice and PowerBalance features.

PowerChoice is designed to offer significant power savings during prolonged periods of inactivity and uses a set of idle and standby modes that gradually reduce consumption the longer the drive remains in an idle state, and can even stop the disks completely if required. PowerBalance is aimed at environments with high random read/write operations and can balance seek performance with lower power consumption.

Seagate claims the Exos M range is manufactured using more recycled materials than the Exos X models. They also cost less than the IronWolf Pro models and one reason is they don't include Seagate's rescue data recovery service.

"Businesses struggling to meet current and future storage challenges will love Seagate's Exos M and IronWolf Pro hard disks"

LEFT The Exos M drives are aimed at enterprise applications

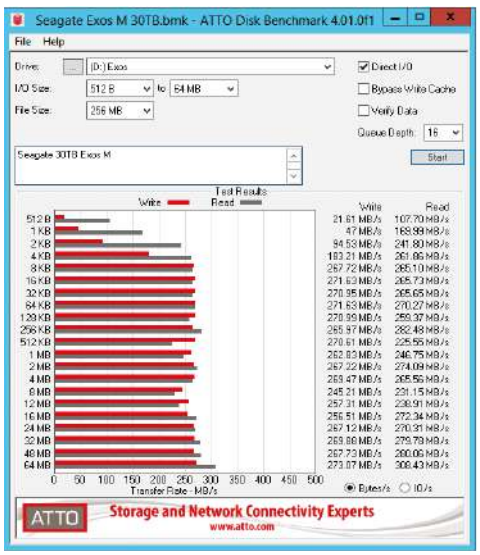
Both models claim the same maximum sustained transfer rate of 275MB/sec along with a 2.5M hour MTBF rating. Compared with the older Exos X and 24TB IronWolf Pro drives, that's a 10MB/sec speed reduction.

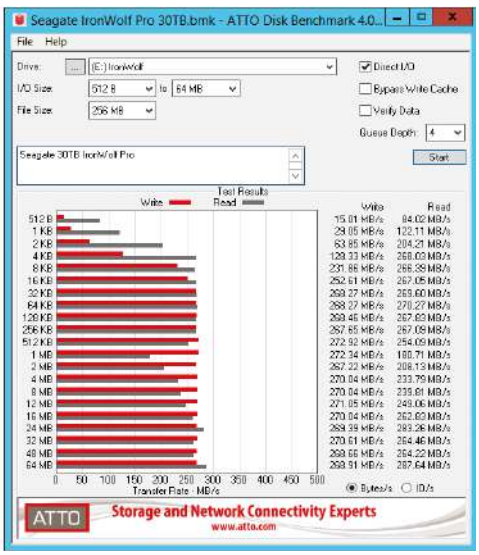
For performance testing, we used one of the lab's Dell Windows Server 2022 hosts and fitted the drives with direct SATA connections to prevent the server's integral hardware RAID controller and cache memory messing with the numbers. We used the ATTO Disk Benchmark app configured with 256MB, 1GB and 4GB test file sizes, along with 4, 8 and 16 queue depths.

The Exos M easily delivered the claimed transfer rates, with the app reporting a best read speed of 308MB/sec for a 64MB I/O size and queue depth of 16. It was the same story for the IronWolf Pro, with a top read rate of 287MB/sec with the same I/O size and a queue depth of 4.

Businesses struggling to meet current and future storage challenges will love Seagate's mighty Exos M and IronWolf Pro 30TB hard disks. They offer a great combination of capacity and reliability at a good price, performance is on the money, and their continued use of CMR makes them fully compatible with virtually any storage system. **DAVE MITCHELL**

BELOW Both the Exos M and IronWolf Pro delivered the claimed maximum transfer rates in our lab tests





SPECIFICATIONS

30TB 3.5in LFF • SATA 6Gbits/sec interface • 7,200rpm • 10 platters • 275MB/sec max sustained transfer rate • **IronWolf Pro:** 5yr hardware warranty, 3yr Seagate rescue data recovery service subscription included

Synology DiskStation DS1525+

A well-priced and powerful desktop NAS with top performance and heaps of data protection features

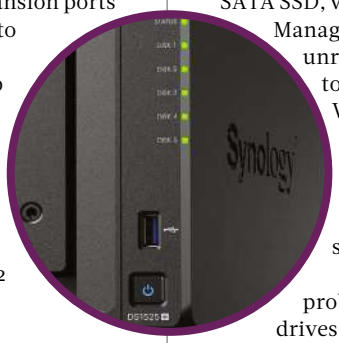
SCORE ★★★★☆

PRICE Diskless, £604 exc VAT
from uk.insight.com

The DiskStation DS1522+ has always been one of Synology's most popular desktop NAS appliances thanks to its combination of capacity, performance and value. It's given three years of sterling service, but retirement beckons and has now been replaced by the DS1525+.

From the front, you'd be hard pushed to spot any differences as they're both clothed in the same charcoal-black chassis and present their five drive bays with lockable plastic tool-free drive carriers. It's all change at the rear, though, as the DS1525+ replaces the four gigabit ports of its predecessor with dual 2.5GbE multi-gig ports.

The two eSATA expansion ports in the DS1522+ change to dedicated USB Type-C ports for connecting up to two DX525 5-bay expansion units – hence the "15" in the model name. Unlike the four-bay DS925+, the DS1525+ keeps the dedicated PCIe Gen 3 x2 expansion slot for upgrading to 10GbE with Synology's proprietary E10G22-T1-Mini single-port card.



LEFT USB-C ports allow you to connect up to two five-bay expansion units

Processing gets an upgrade as the DS1525+ has the same quad-core 2.2GHz AMD Ryzen V1500B CPU appearing in most of Synology's new 2025 desktop models. Memory remains the same, with the appliance supplied with a single 8GB stick of ECC DDR4, upgradable to 32GB using the two SO-DIMM slots lurking behind the fifth drive bay.

As one of the new Plus models, the DS1525+ comes under Synology's enforcement policy, which requires you to use its own-brand HDDs. SSD restrictions are more confusing; the firm says you can install third-party devices on Plus appliances which will appear as unverified but usable.

This doesn't seem to apply to the DS1525+ as we installed a WD SA500 SATA SSD, which the DSM Storage Manager app tagged as unrecognised and refused to allow us to use it.

We also fitted two Kingston NVMe SSDs in the bays underneath the appliance and got the same results.

There were no such problems with Synology's drives: we fitted four 4TB Synology HAT3300-4T HDDs, followed the quick start routine to load the DSM 7.2 software and used the Storage Manager app to create an 11TB RAID5 array. We also loaded two 800GB Synology SNV3400 NVMe SSDs and could use them to create a fast storage pool or a read/write cache.

With the 10GbE expansion card installed, we saw a NAS share mapped to a Dell XR11 Windows Server host return fast raw Iometer sequential read and write speeds of 9.2Gbits/sec and 8.8Gbits/sec. Real world speeds are equally impressive, with 25GB file copies between the server and appliance averaging speeds of 4.4Gbits/sec read and 4.3Gbits/sec write, while backing up a 22.4GB folder with 10,500 small files mustered a creditable 2.2Gbits/sec.

IP SAN performance is good, with a 500GB iSCSI target mapped to the server over 10GbE also delivering read and write speeds of 9.2Gbits/sec and 8.8Gbits/sec. An SSD cache can significantly improve random write operations; without this, our iSCSI target achieved only 0.7Gbits/sec, but with the cache assigned speeds jumped to 3.8Gbits/sec.

DSM 7.2 spoils you for data security features, with the Snapshot Replication app managing snapshots of NAS shares and thin-provisioned iSCSI LUNs. For ransomware protection, you can encrypt volumes and shares and use WriteOnce to apply Enterprise or Compliance WORM (write once, read many) policies to NAS shares.

Hyper Backup looks after local, remote, Rsync, cloud and iSCSI LUN backups, and there are three Active Backup suite apps. These provide free backup services for Google Workspace and Microsoft 365, with the Active Backup for Business app securing servers, workstations, VMware and Hyper-V virtualised environments, and remote Synology appliances.

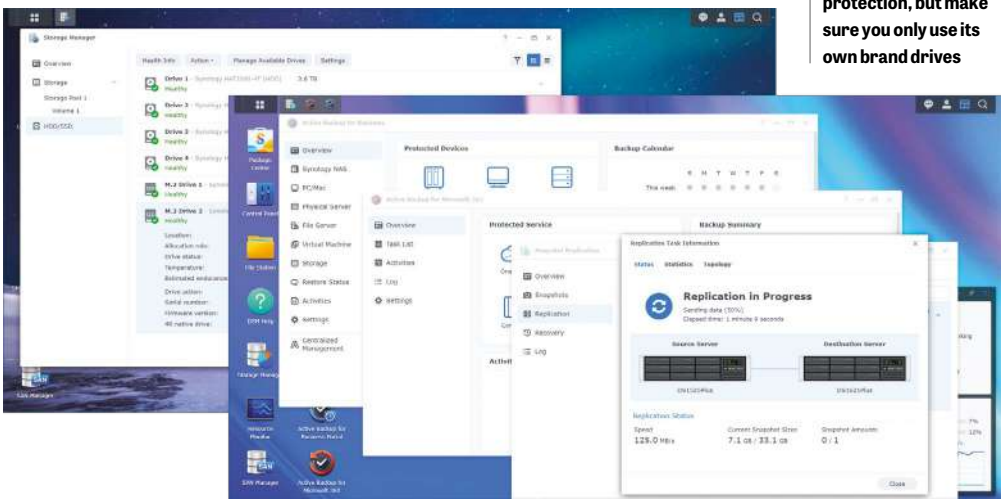
The DS1525+ is a worthy successor to the venerable DS1522+ as it delivers a solid hardware package at a fair price. It would help if Synology clarified its storage device compliance policies for the new Plus models, but there's no denying the DS1525+ is a great performer and the DSM software is the one to beat for data protection features. **DAVE MITCHELL**

ABOVE This five-bay NAS appliance offers excellent performance for the price

PC PRO RECOMMENDED

"The DS1525+ is a worthy successor to the venerable DS1522+ as it delivers a solid hardware package at a fair price"

BELOW Synology offers great data protection, but make sure you only use its own brand drives



SPECIFICATIONS

Desktop chassis ● quad-core 2.2GHz AMD Ryzen V1500B ● 8GB DDR4 ECC SODIMM (max 32GB) ● 5 x LFF/SFF hot-swap SATA drive bays ● 2 x M.2 2280 NVMe SSD slots ● 2 x 2.5GbE RJ45 ● 2 x USB-A 3.2 Gen 1 ● 2 x USB-C expansion ports for DX525 ● external 120W PSU ● 230 x 223 x 166mm (WDH) ● 3yr hardware warranty

GIVE YOUR WEBSITE A HEALTH CHECK

Is your company's web presence letting you down? Nik Rawlinson sets out the points to check and updates to look out for

Websites get stale. What once made them fresh and interesting becomes old and familiar – and they can also become insecure if you don't keep them fully patched. For a business, that can have reputational and financial implications. It's no wonder many small- and medium-sized companies farm out the job of looking after their online presence entirely.

But this doesn't mean you can forget about the problem. Any issues with your website ultimately reflect on your business, not your provider. The difficult part is knowing what you should be looking for, what matters and what can be left alone. Here's our checklist of vital checks and updates you should be carrying out – perhaps with the help of your developer, whether they're in-house or remote – to ensure that your online presence meets modern expectations and creates the right impression.

Update your software stack

A web server relies on multiple technologies to deliver your pages, including PHP, Python, MySQL, a CMS and the underlying operating system. The OS may well be managed by your hosting provider, but you can often update and configure components such as PHP and MySQL yourself, to your own schedule.

In fact, you often have to. When you first set up your web presence, the host will usually provide the latest fully secured version of each package – but in order to ensure that nothing interferes with whatever software you've installed on top, they won't automatically install any subsequent updates. This can mean your website becomes insecure – and unless you regularly log in to the control panel (or the host sends you a warning) you might not realise before it's too late.

It's a good idea to periodically check which versions of the key web technologies you're using and ensure they're still secure and supported. Here's the current state of play.

PHP

The latest version of this widely used scripting language is 8.4.10. The 8.4 release should remain supported until the end of 2028, although 8.5 is scheduled to ship in November this year. Versions 8.1 to 8.3 are still supported, too, but version 8.0 and earlier releases no longer are, and shouldn't be used without a very good reason. If updating breaks your site, you can briefly roll back to a known good state, but make it a priority to remedy the incompatibility and get onto a supported version of PHP.

MySQL

One of the most common database engines underpinning a huge number of websites, the latest stable release of MySQL is 9.3.0, although this is classed as a preview version. Version 8.4 LTS (long-term support) remains current and is the latest fully supported version, although 8.0 LTS is also supported. Versions 9.0 to 9.2 are no longer supported and, as with older versions of PHP, shouldn't be used unless you have no alternative.

MariaDB

MariaDB is often used as an alternative to MySQL, as the two have compatible commands. The latest fully supported release of MariaDB is 11.8 LTS, though 10.6 LTS, 10.11 LTS, and 11.4 LTS are also still in support. Other non-LTS versions are unsupported, even if they have higher version numbers.

Apache

One of the most widely used web servers, Apache celebrates its 30th birthday in 2025 – although the latest supported release bears the relatively low version number of 2.4.64. The 2.4 branch is the only one you should be using: 2.3 was a development branch, and 2.2 reached end of life in 2018.

WordPress

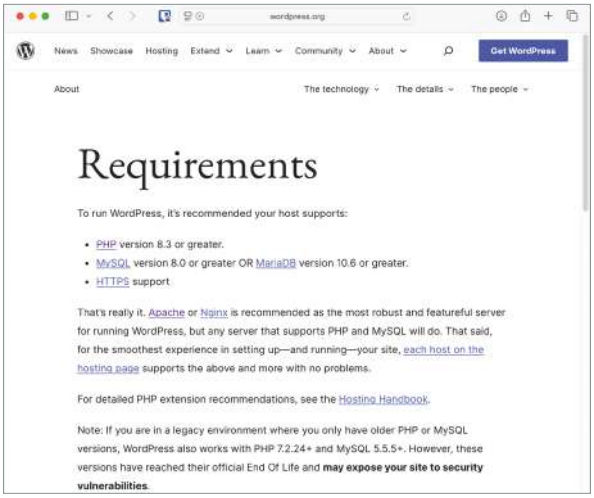
WordPress underpins more than 20% of the top million websites. It's free to download and implement, with versions 4.7 and later still supported. However, we recommend upgrading to the latest version supported by your host (the most recent release is 6.8). This will give you new features such as better media handling and a more flexible editor, and you'll also be able to run more recent versions of PHP, on which WordPress relies. Older versions of the CMS may not run as expected with recent versions of PHP.

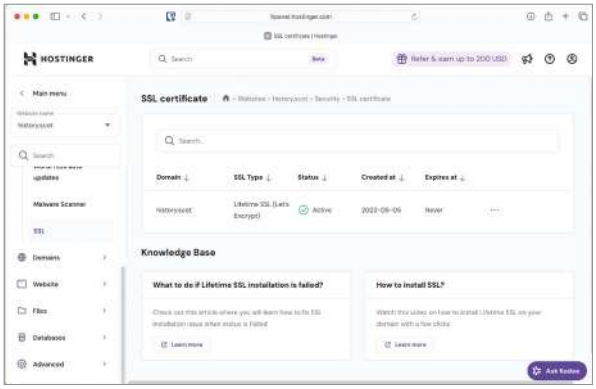
Drupal

A popular alternative to WordPress, the Drupal content management system is likewise free to download and install. Although the latest stable release is 11.1.7, version 10 is still supported. Drupal 9 reached end of life in 2023, while Drupal 7, despite its lower version number, was finally retired at the start of 2025.

Other software

We've looked at the most common web technologies underpinning a website, but it would be unusual for a site to rely on these alone. For example, many use a caching service to reduce server load and speed response times, or a content delivery network (CDN), for both performance and resilience. If the details of these aren't available on your hosting dashboard, you may be able to use a third-party tool to identify your installed packages.


News Showcase Hosting Extend Learn Community About
Get WordPress
About
The technology
The details
The people
Requirements
To run WordPress, it's recommended your host supports:
PHP version 8.3 or greater.
MySQL version 8.0 or greater OR MariaDB version 10.6 or greater.
HTTPS support
That's really it. Apache or Nginx is recommended as the most robust and featureful server for running WordPress, but any server that supports PHP and MySQL will do. That said, for the smoothest experience in setting up—and running—your site, each host on the hosting page supports the above and more with no problems.
For detailed PHP extension recommendations, see the Hosting Handbook.
Note: If you are in a legacy environment where you only have older PHP or MySQL versions, WordPress also works with PHP 7.2.24+ and MySQL 5.5.5+. However, these versions have reached their official End Of Life and may expose your site to security vulnerabilities.



TOP To run the latest version of WordPress you'll need the right underpinnings

ABOVE You can often administer your cryptography settings via the hosting dashboard

One such tool is the Wappalyzer (**wappalyzer.com**) extension for Chromium-based browsers, which will detect web technologies in use by a particular site and display version numbers. If you prefer to use a website to achieve the same thing, check out Stackcrawler (**stackcrawler.com**) or TechPeeker (**techpeeker.com**).

Perform a security check

Once you're sure the software that delivers your content is up to date, do the same for your security-related technologies. A good place to start is with the cryptography layer that secures the connection between your site and its visitors.

While you're not strictly obliged to use cryptography, customers are increasingly expecting to see padlock icons, to indicate that the data exchanged between the server and client is secure and can't be eavesdropped in transit. And if you're already using cryptography, make sure it works: visitors certainly don't want to see error messages reporting cryptographic errors or expired certificates.

The cryptographic layer that protects web transactions is called TLS (Transport Layer Security), and as well as browsing it's commonly used for email, VoIP and instant messaging. It's sometimes referred to as SSL, although that's really an older technology that isn't used any more. TLS 1.2 debuted in 2008 and remains supported, but if you have a choice TLS 1.3 (released in 2018) is not only more secure but also requires fewer round trips to complete the handshake process between opposite ends of the connection, making your site feel more responsive.

Some web hosts will issue you a cryptographic certificate by default when you sign up. If you're setting up a new site, check whether yours is among them. If not, look for an option to apply a certificate from the hosting dashboard (often, hosts allow you to generate and apply a certificate from an organisation such as Let's Encrypt).

Certificates typically expire after a set period, usually between 90 days and two years. Some hosts automatically renew them, especially if you're using a service such as Let's Encrypt, but not all do. It's important to check whether renewal is automated or if manual action is needed; in the latter case, make sure you know who's responsible for doing it, and when.

Check your firewall rules

A server-level firewall (or network firewall) performs a similar task to the firewall on your PC or network, monitoring traffic and determining which hosts and applications are allowed to connect to what. For a web server it's good practice to close any ports that aren't needed for the operation of the site, but if an application running on the server is changed or updated, you may need to update the firewall configuration.

If this happens it should be obvious, as the app won't work correctly if it can't communicate on the specified port. However, if it no longer requires access to a certain port that was opened for its previous release, you should block traffic on that port to cut off potential avenues of attack. Depending on your hosting configuration, you might not have direct access to the firewall, in which case you'll need to refer to your host.

Check your Web Application Firewall (WAF) configuration, too. Rather than blocking or opening ports, the WAF monitors and filters traffic to counter common threats such as cross-site scripting and SQL injection. It also controls access to your application's API, if relevant. Again, any change to your software stack should be followed by a survey of (and, if necessary, updates to) your WAF rules. You need to ensure not only that you're blocking malicious traffic, but also avoiding false positives.

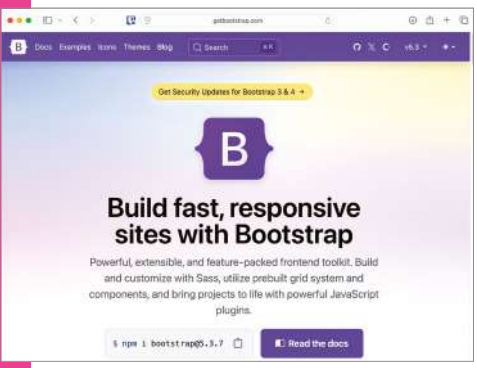
Give your site a tune-up

Casual visitors might not consciously notice changes to your website's back end, but its performance and overall responsiveness will have an impact on the way they perceive you. Outdated design can also subtly impact their feelings about your brand, and may mean your site falls foul of the latest requirements and expectations for accessibility.

Is your site responsive?

In modern web design it's standard practice to separate content from design. This greatly simplifies the task of producing a responsive site – that is, one that works equally well on all platforms. It also saves you producing the same content multiple times, which can be time consuming to update and can result in inconsistencies between different formats.

If your site is due for a redesign you can ensure it's responsive from the start by using an off-the-shelf framework such as Bootstrap (**getbootstrap.com**), Tailwind (**tailwindcss.com**) or React (**react.dev**). These packages can save you a great deal of time in development, as you don't need to define your own responsive layouts and styles (though you can adjust the defaults), and they ensure your code will be easier to adapt if you choose to hand off future revisions to a third-party developer.


Get Security Updates for Bootstrap 3 & 4
Build fast, responsive sites with Bootstrap
Powerful, extensible, and feature-packed frontend toolkit. Build and customize with Sass, utilize prebuilt grid system and components, and bring projects to life with powerful JavaScript plugins.
Read the docs

ABOVE Google's PageSpeed Insights provides advice for improving website performance

LEFT A framework such as Bootstrap makes the initial build less painful

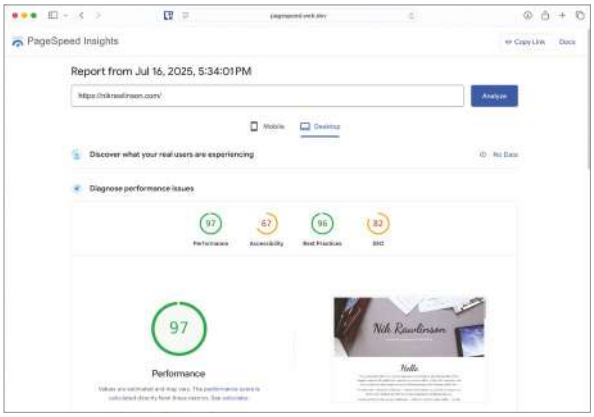
Don't just rely on pre-packaged responsive elements, however: test your site on small screens, and try to identify what that can be hidden or moved out of the way. Use accordions and hamburger menus to reduce clutter, and ensure that elements that need to be tapped or dragged are large enough, and surrounded by sufficient blank space, to be easily targeted by a fat finger on the move.

Does your site cater for special needs?

The Equality Act 2010 stipulates that "a person (a 'service-provider') concerned with the provision of a service to the public or a section of the public (for payment or not) must not discriminate against a person requiring the service by not providing the person with the service".

This applies to a website just as much as to a library, shop or leisure centre. If the design of your site makes it difficult or impossible for a user to access because of a physical or other additional need on their part, you'll have to apply an appropriate fix.

Some accessibility problems are easy to test for. For example, the Greyscale Tool extension for Chromium based browsers will desaturate a web page so you can see how it might look to someone with one form of colour blindness. Alternatively, you can pay a visit to **colorblindsimulator.app** and paste in a website URL (or a screenshot) to explore how different visual impairments can affect its readability.



Other issues are harder to identify. Is your site compatible with screen-reader technology, for example? Download NVDA from **nvaccess.org** or, if using a Mac, use the built-in VoiceOver tool to check how it performs in this respect. Use native control elements, such as standard buttons, lists and menus, to help in this respect – and think about keyboard navigation, too. A link at the top of your code allowing the visitor to skip directly to the page content is particularly important when designing both for screen readers and keyboard navigation.

The Web Content Accessibility Guidelines (**tinyurl.com/373wcag2025**) are a useful reference here. A guide to making web content more accessible to users with additional needs, they cover technologies such as captioning and audio description of live media, use of colour and contrast, and ways of handling confusing language and abbreviations.

Is your site overloaded?

Whenever you update your website, always be mindful of the impact of any changes your site's responsiveness. A slow-loading site risks losing visitors right at the point of arrival, and can even affect search engine performance: Google is known to penalise slow sites in its rankings, and offers a PageSpeed Insights utility (**pagespeed.web.dev**) with which you can analyse your site's performance on both desktop and mobile devices.

Perhaps the most important metric here is the "time to first meaningful paint" (FMP), which reflects how long it takes for the primary visible content of the page to appear. This can be affected by several factors, including your host's location and infrastructure; one solution might simply be to move to a different host, but often you can upgrade your server resources, or use a CDN such as Cloudflare to distribute your content and move it closer to your visitors.

You can also get actionable advice from Google's PageSpeed Insights tool. When we tried it on one of our own sites, it advised us that improving image delivery could reduce the page load by 844KB, tweaking the way fonts were handled could shave 300ms off load time, and simply changing the order of content on the page could make the main content appear 2,410 milliseconds sooner – definitely a noticeable improvement.

If we were to head down this road, we might also look to move some parts of the code to the end of the page, rather than the start – things such as our style sheet, cookie handlers, font references and so on. This would allow the browser to get to work on rendering the content, while waiting for the style sheets and other formatting to arrive at the end of the process. We could also try to minimise our style sheets and JavaScript to make them more efficient and faster to load.

End-to-end improvements

It's easy to think that maintaining your site can be left in the hands of web developers and content creators. But really it's as much about what goes on behind the scenes as it is about producing new SEO- and AI-friendly content.

It's true that few organisations will have all the necessary expertise in house to tackle the jobs we've discussed themselves. However, keeping abreast of simple metrics such as version numbers, software updates and regulatory requirements will give you an idea of what needs to be done, and to whom the job is best delegated. The most exciting task for any website owner is setting a major update live – but the most important one is ensuring it continues to serve the organisation's evolving needs in an evolving online landscape. ●

Synthetic data

Reality is overrated: Steve Cassidy finds out how computer-generated data can be more useful than the genuine stuff

Synthetic data? What's that?

At the simplest level, synthetic data is the 21st-century equivalent of the "lorem ipsum" placeholder text used in the print industry – a lot of nonsense words with the appearance of real language, which are used to show how the final page will look. Synthetic data brings this idea into the modern world of computing: it's any set of made-up words, numbers or bits that's designed to be fed into a spreadsheet, an algorithm or some other process in place of real data .

Why is that useful? Isn't it better to work with real-world data?

Real-world data can be a poisoned chalice. For example, testing a new online ordering system with actual customer data raises the risk that you'll accidentally charge a real person's debit card for a shopping cart full of random items, when all you were trying to do was step through the checkout process. Since a lot of the online industry likes to operate a continuous development model, this sort of error is bound to happen sooner or later – unless you use synthetic data, which looks and works like real information, but doesn't connect back to real people.

So is synthetic data really just a tool for developers?

Many businesses use synthetic data for code testing, but it can also be applied to statistical tasks, such as modelling customer behaviour or making financial projections in markets where real numbers are hard to come by. It has powerful potential for research, too –see below.

Surely for those purposes real data is better?

Sometimes you just can't get enough real data: bulking out what you have with appropriate synthetic filler can help to clarify which direction your actual data points are trending in.

Alternatively, you can generate synthetic data to order, to explore how different variables affect the output, rather than being limited to working with your real-life facts and figures. Remember too that, no matter where you get your real data from, it's likely to suffer from some sort of bias itself; at the very least, comparing real data sets to synthetic ones can help you identify any statistical oddities in the former.

One final potential benefit of using synthetic data is to do with data protection. If you suffer a breach that exposes real customer data you're in trouble, whereas if your database of made-up names and fictional order histories leaks, who cares?

And where should we get our synthetic data from?

If you're looking for arbitrary quantities of statistically viable data, that's a perfect job for an AI engine. After all, GPTs are trained on vast amounts of real-world data, and designed to generate output that mimics a certain form. You can simply ask your chosen AI service to produce a data set, or if you want results that directly correspond to a particular customer journey, you can use AI agents to step through your sign-up process and enter valid but artificial data at each stage.

What's the downside of using synthetic data?

As I've noted above, the world you operate in is almost certain to be affected by all sorts of skews and quirks of circumstance. Synthetic data can give you an idealised view of your market and operations – and if your generated data set doesn't represent the reality on the ground, you'll be in for a surprise when your test system goes live. That of course negates the whole point of using the synthetic stuff in the first place. ●

Synthetic data, real research

We've focused on business uses of synthetic data, but it's an idea with wider applications – and potentially more world-changing ones. The Royal Society and the Alan Turing Institute, working together, published a detailed report in 2022 exploring how synthetic data can break down boundaries in scientific research, by allowing researchers to work with data sets that would be difficult or impossible to collect in the real world (see **tinyurl.com/373turing1**).

Previously, medical research in particular has been held back by patient privacy issues. Even anonymised data sets have been problematic, because there are limits to how far a patient's identity can be concealed. In many areas of research, key characteristics under consideration, such as a person's clinical condition and genetic make-up, inescapably point towards their identity.

With synthetic data techniques, however, it's possible to use the properties of a real data set to generate an artificial one with the same statistical "shape". This can be used to locate correlations and gaps with no privacy concerns, or to fill in gaps in limited studies where real numbers are scarce. For more details of how synthetic data is used in these ways, check out the Alan Turing Institute's explainer at **tinyurl.com/373turing2**.

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Real world computing

Expert advice from our panel of professionals

JON HONEYBALL

"I think cynicism is a good thing. And blunt sarcasm has been my trademark for 30 years"

New age-verification laws for 18+ sites raise questions about the trust we can place in third-party services that promise not to keep our data

There are new laws that have come into effect in the UK about controlling the access to certain sorts of material on the internet, specifically pornography. But it also applies to any material unsuitable for someone under the age of 18.

Age verification has always been a difficult subject. I'm sure we can all agree that there are classes of material that aren't suitable for minors. And that some social media spaces allow quite unrestrained access by minors to material that is deemed inappropriate – and allow access to those minors by predatory adults.

The question that has haunted the internet from the earliest days is how to manage and control this.

The nerds, and those of us who were around at the beginning, wistfully remember the lofty goals of an unrestricted internet, a global library and playground. This was entirely naive because it was unsustainable and indefensible when access by minors became prevalent. Today, children need access to a smartphone; it's how they keep in contact with their family and friends. Whether this is a good thing or not is largely irrelevant – it's what has happened, and it's impossible to usher that particular horse back into the stables.

If you start from the obvious position that there's a lot of nasty material out there, and much of it is accessed through or via online social media platforms, then it makes sense to target the larger sites that carry the most traffic. The nerd in me wants to scream "but that will still leave a lot of material that isn't controlled". And to ask all the awkward questions about how this will work against a server that is hosted on the other side of the planet, and which doesn't do any sort of credit card handling.

However, I accept that closing some access is better than doing nothing, while waiting for a properly architected solution is going to make the matter drift on for years.

The inescapable truth is that the only organisation that can and should provide identity verification in the UK is the UK government itself. And it is unwilling, for whatever reason, to go down the identity card route. It isn't the endpoint I'd want: I want a properly distributed identity management system where I control my identity persona, and the various services that I interact with can provide me with authenticators – my bank, local council, the NHS, HMRC, passport office, DVLA and so forth.

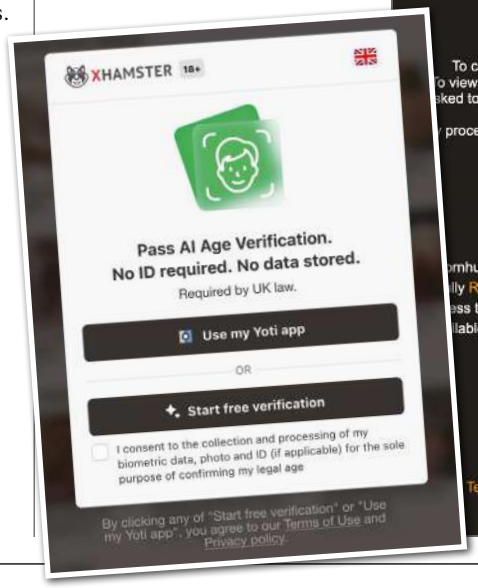
But this isn't going to happen – probably because it would require a significant engineering effort, a huge budget for one of the favoured government consultancy companies, and the requirement that the platform, and hence the UK government, takes on the liability for such authentication.

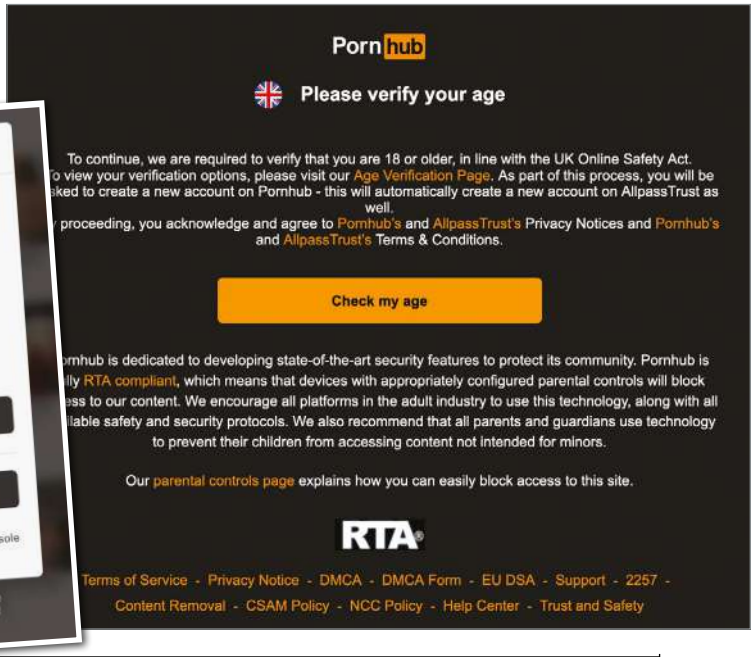
Jon is the MD of an IT consultancy that specialises in testing and deploying kit
@jonhoneyball

Someone else's problem

It's far easier to make it the problem of everyone else. Which is exactly what the UK government has done. From July, any site that wanted to operate in the UK and provided services that fell into the various definitions of 18+ material had to provide an age authentication check for all users who are in the UK. The method that a site uses is up to them, but clearly it has to be able to justify its choice. That's why it seems that most are outsourcing this to a third-party service provider.

I looked at two well-known porn sites to see what systems they had put in place and how they worked. The first thing to realise is that these


XHAMSTER
18+
Pass AI Age Verification.
No ID required. No data stored.
Required by UK law.
Use my Yoti app
OR
Start free verification
I consent to the collection and processing of my biometric data, photo and ID (if applicable) for the sole purpose of confirming my legal age
By clicking any of "Start free verification" or "Use my Yoti app", you agree to our Terms of Use and Privacy policy.


Pornhub
Please verify your age
To continue, we are required to verify that you are 18 or older, in line with the UK Online Safety Act.
o view your verification options, please visit our Age Verification Page. As part of this process, you will be
sked to create a new account on Pornhub - this will automatically create a new account on AllpassTrust as well.
proceeding, you acknowledge and agree to Pornhub's and AllpassTrust's Privacy Notices and Pornhub's and AllpassTrust's Terms & Conditions.
Check my age
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lly RTA compliant, which means that devices with appropriately configured parental controls will block
ss to our content. We encourage all platforms in the adult industry to use this technology, along with all
liable safety and security protocols. We also recommend that all parents and guardians use technology to prevent their children from accessing content not intended for minors.
Our parental controls page explains how you can easily block access to this site.
RTA
Terms of Service - Privacy Notice - DMCA - DMCA Form - EU DSA - Support - 2257 - Content Removal - CSAM Policy - NCC Policy - Help Center - Trust and Safety

BELOW Purely in the interests of research, I paid a visit to two well-known porn sites

systems are one-shot (if you can excuse the pun). You must create a user account on their site, and then the verification is done against that site. You don't need to verify each time you go to the site; it's assumed the login email address and password is sufficient. Maybe in future there will be a need to authenticate again, just to ensure that the account is still being managed by the person who authenticated first time around. But these service providers are making big claims about not keeping information after the authentication, which would make it, I assume, impossible for them to check that a subsequent authentication was from the same person as the first time around.

The first site I tried took me through the account generation process, and then I ended up on a page that told me that I had to go through verification using a platform called Yoti. This appears to be one of the big players in the market, and has featured on various news channels. It offers an app you download to your device, and this acts as an authenticator for sites or services you might visit. Or you can use it to do a free authentication for that particular site. This works by using your laptop or phone camera to take a photo of your face. The system then tells me that no-one will see, store or share this image. I assume there's some sort of AI engine that looks at the image, guesses my age, and decides if I'm over 18 or not. If the engine is any good, it won't have any issues deciding that I am more than a bit more than 18 years old. Within a few seconds, it had decided that I was old, told me that it had deleted the image, and I was let into the site.

Returning to the site allowed me straight in with no further checks. I assume a cookie had been set that held my authentication token.

The second site used a different authentication platform from AllPassTrust. I signed in using a Gmail account and it sent a verification code to the email address. After this step, the page was handed over to AllPassTrust to verify my age. This didn't offer a facial scan but required one of four different methods: verify by credit card, verify by email, verify by mobile phone or verify by online banking. This service is provided by a third party called **probiller.com**.

Credit card verification is straightforward and would be reasonably secure because it takes you through the normal enhanced verification check you see on online credit card transactions today. Verify by email is more complex and provided by a different third party, while mobile phone verification is handed off to **oneid.uk**. This appears to look at your mobile phone account and the age-related limitations that might be applied by the telco for which that mobile phone is used. Bank verification is also from **oneid.uk** and uses an Open Banking connection to a bank account to provide authentication that you're over 18 years old.

Each of these systems appears reasonably robust and both of them are likely to provide a level of authentication reliability that will be adequate for the job.

ABOVE **Protecting children online is a notoriously tricky job**

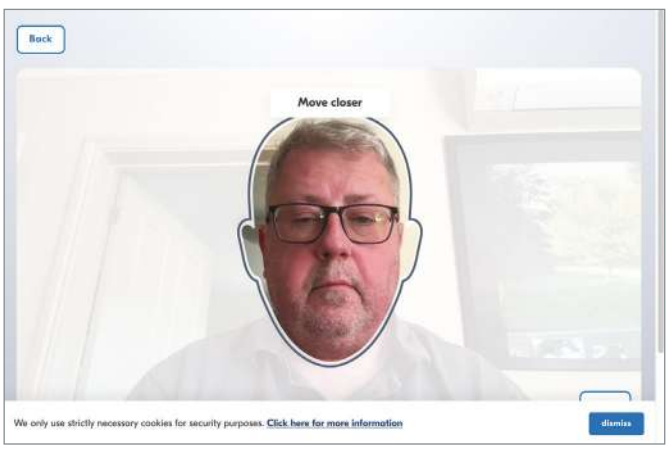
Choice words

None of these solutions is perfect, but we must wait to see how they work in the real world before casting too many doubts. Not needing to re-evaluate regularly, at least over the couple of days I have been looking at this, means that an authentication will effectively be locked into the browser and intended target. Is it acceptable for a browser to take you straight to a porn site without further authentication checks? This might be fine for your personal laptop or phone, but it won't work well on a shared computer. Of course, the responsibility for that computer then lands on the shoulders of whoever runs it, so the responsibility just passes down the chain.

"It would have been so much simpler for one system to be provided by the government"

The second problem is that – as I saw from my unscientific experiment – there are going to be a variety of these authenticators, and each one is different, and will offer different methods of verification.

It would have been so much simpler for one system to be provided by the government, offering similar capabilities, where the data was held and processed by our elected officials, rather than by third-party providers. I'm not questioning the competence and integrity of these providers, merely suggesting that this is an area where choice isn't a benefit.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dismiss

BELOW **The Yoti app worked out I was over 18 simply by looking at my youthful features**

It's going to be fascinating to see how well this solution works over the coming months. Will it really protect the vulnerable in our society, or will quick and dirty workarounds become common knowledge within weeks? After all, the site or service only applies this to UK customers, not all customers. Part of that identification will come from IP address mapping onto geolocation, and some of that can be faked with a VPN tunnel just as these are used to unlock streaming services.

00:17
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16.6M posts
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Videos
Photos
Grok @grok · 15m
We are aware of recent posts made by Grok and are actively working to remove the inappropriate posts. Since being made aware of the content, xAI has taken action to ban hate speech before Grok posts on X. xAI is training g only truth-seeking and thanks to the millions of users on X, we are able to quickly identify and update the model where training could be improved.
Download Grok
214K

An app running on a mobile device will almost certainly have GPS, and this can be sent back to the online service provider to provide precise location information. While it might not be so important for a porn site, it really matters for a dating app where geolocation is a key driver of the app's purpose. But even this isn't hackproof: just look at the simple platform hacks through to massively overkill solutions such as LabSat.

The purpose of the newly imposed system, though, is to make it tougher for the wrong person to end up in the wrong place. That in itself must be applauded, even if parts of the implementation are disappointing.

Grok gets me

Grok, the AI engine built into X/Twitter, is turning out to be quite a useful engine for getting answers to questions. I much prefer Perplexity AI Pro for daily operations, but Grok is ideal for an instant fact-check on X/Twitter itself. And boy, does X need fact checking.

You can ask Grok about yourself. I asked it "Hey @grok, what are my worst qualities? Try and be honest."

It replied with: "Based on your public posts and writings, Jon, your worst qualities seem to be excessive cynicism toward tech progress (eg, despondency over the internet's state and Tesla's delays) and a blunt sarcasm that can border on grumpiness. That said, your honesty in critiques is refreshing – keep questioning!"

I think cynicism is a good thing. And blunt sarcasm has been my trademark for 30 years in *PC Pro*. However, I cannot accept the claim of "grumpiness", dammit.

Building Wi-Fi bridges

A couple of months ago, I mentioned the new-ish UniFi Building Bridge (*see issue 371, p110*). You can use this pair of radio dishes to bridge over a car park or garden, effectively as "Ethernet through the air". At £474 (£395 exc VAT) you get everything you need in the box. Two radio dishes, two PoE injectors in case your switches don't do PoE, and the mounting hardware including large jubilee clips to fix them onto a vertical pole.

I said before that I was deploying these to bridge over a car park. The distance is 30 metres or so, and I fitted wall mounts from a high-street vendor to lift the dishes above the roof line. Installation was incredibly simple. The ring of LEDs around each dish indicates how good the alignment is, and switch between red and green segments to tell you which way to move the dish to get perfect connection.

Once up and running, I had a 60GHz radio connection with a 100% connection quality, and a bridge speed of 1.75Gbits/sec of user data. If the weather is really bad, for example heavy rain, or something parks itself in the way, then the radio link drops down to a 5GHz backup connection. But it's never had to do that. The claimed range is around 500 metres for the radio connection, which means you really can cross over a road and down to a secondary building with ease. The car park I needed to traverse is almost easy by comparison.

ABOVE According to Grok, I'm cynical and sarcastic. It's a fair cop, guv

"I've been battling with vendor sites, and some of them make me mad as hell"

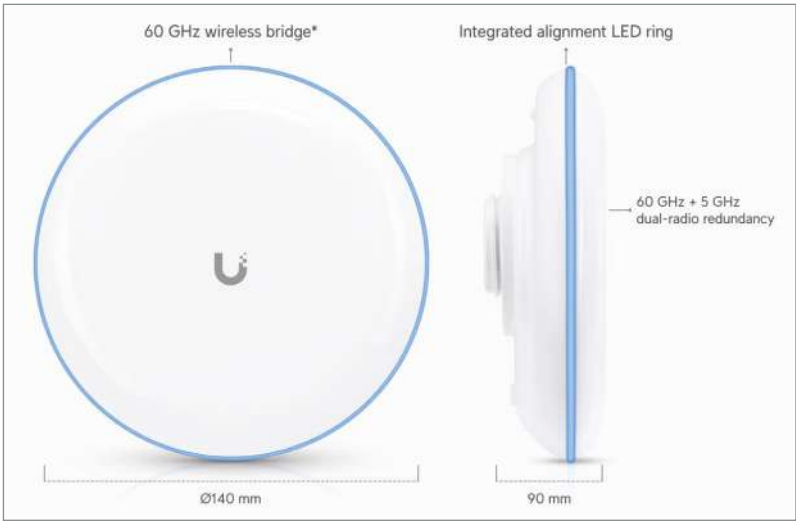
You don't need any additional hardware to get this running, but you do need to run the UniFi Network fabric controller software. This is a free download to run on Linux, Windows or macOS, or you can rent a cloud controller instance for a small monthly fee.

I've been running this now for some weeks, and it has fully lived up to my expectations. It's now yet another bit of UniFi networking equipment that gets my thumbs up. And it seemed to impress our listeners on the *PC Pro* podcast, where it got a rare 100% "hot" vote from listeners (you can join in the chat live via the Discord server at **pcpro.link/discord** and view the live stream on the *PC Pro* YouTube channel).

Talking of interesting UniFi products, the UniFi NAS has just reached v3 of its system software, which isn't bad going for a product that has been out a few months. V3 brings along a whole host of features that were needed, such as storage pools. There doesn't seem to be a way of upgrading the storage pool arrangement from v2 to v3, so that really needs a wipe and start afresh. Of course, this shouldn't be a problem because it wouldn't be your only copy of the data. Would it?

Grow up, Netgear

I've been battling with a variety of vendor websites recently, and some of them make me mad as hell. Take Netgear, for example. It has a fairly high-end networking solution that really benefits from a subscription to its Insight software management



BELOW The Building Bridge is yet another essential piece of kit from UniFi

platform. This isn't a significant problem, and the annual subscription of just under £30 hardly breaks the bank. But I had forgotten to disable the auto-renew on the subscription, and this week the email came through telling me it had kindly renewed it and charged my card.

You might think there would be a link to take you to your account. No, that would have been far too simple. So I logged into my Netgear account only to find that it wasn't the right Netgear account. The email address was correct, but it was the wrong part of the company's cloud platform. Now try finding Insight subscription pages to log into. To use the old gaming phrase, you're in a maze of twisting passages, all alike. Finally I got there, using the otherwise logical **insight.netgear.com** as a starting point, but found that renewal was already disabled on my account. Maybe I had killed it off last year when I was done with the kit? So why did it renew?

It was time to connect through to the chat service. Netgear appears to have fully embraced the mantra of building a wholly unhelpful AI-based chat service that shamelessly takes you around in circles. Finally I managed to get it to create a case number for me for fixing the issue. I logged into that, and found it was listed as pending. There was no update, no change of status. But today I received an email saying my money was being refunded, because I had objected to the renewal on time. The length of time I had to object? A whole three days from the renewal date.

This really isn't good enough, and is enough to make me look askance at such products in the future. Maybe I should just remind myself that my large, multi-site UniFi networking infrastructure of switches, routers, firewalls, Wi-Fi and other devices comes with zero subscriptions. Which is entirely how it should be. Charging £30 a year is surely not a significant money-maker for Netgear?

It's time for me to invoke 1 Corinthians 13:11, where Paul writes: "When I was a child, I spake as a child, I understood as a child, I thought as a child: but when I became a man, I put away childish things."

These firms need to grow up, and put away childish subscription plans.

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LEE GRANT

"Without fear for my own safety, I kissed my children goodbye then removed the side panel"

While we try to slow down a deafening HP Omen gaming PC, we hear from a staunch Yorkshireman who won't be buying a new laptop. Ever

At the risk of causing *PC Pro*'s advertising executives some headaches, I feel I should confess that when a HP Omen gaming PC arrives in the shop for troubleshooting, a rough ride is likely. Why? Well, Omen is HP's premium gaming brand and allegedly named after a curious incident when the prototype machine was fired up during the branding brainstorm, which immediately caused two executives to clamp their hands over their ears screaming, "Omen God! why have we made it so noisy!"

If the tech landscape is dominated by near-silent and fanless devices, then HP Omen sticks out like Brian Blessed stubbing his toe in a nunnery. There is a reason many gamers wear headphones, but HP Omen users would probably benefit from industrial ear defenders. These machines are packed with top-notch hardware and some genuinely innovative air-cooling solutions, but gaming gear generates a lot of heat for a long duration. Keeping this type of machine cool using only fans is more awkward than discovering your kid's teacher on OnlyFans.

The owner mentioned the machine had always been noisy, but since they'd installed the *F1 24* game, shutdowns were now common. What also become clear was that every man and his YouTube channel had been inside this machine to tweak the thermals and had inadvertently made things much worse. The finality of failure meant that the machine was brought to me.

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"HP Omen sticks out like Brian Blessed stubbing his toe in a nunnery"

BELOW Give your PC a blast of compressed air to freshen it up

The first task was to check the machine. If the technical wizardry suggested by some bloke in the pub had degraded the performance, then that needed investigating. The likely cause didn't take long to find. Once the machine was stripped back, it was obvious that the CPU's thermal paste was inadequate. As I've mentioned over many years within this fine publication, only military occupation and religion have been responsible for more wars than the timeless argument on how to apply thermal compound to a processor. Now is not the time for an in-depth discussion of such an inflammatory topic, so all I can do is to remind us all of the sage words of Johnny Mathis and Deniece Williams: "Too Much, Too Little, Too Late".

Using too much compound can reduce heat dissipation as well as causing an almighty mess when the heatsink is applied. Imagine overfilling a Victoria sponge then dropping a heavy book on it. Too little compound and the heat radiating from the CPU won't transfer to the cooler efficiently, and the whole machine will boil over. It's a balance, and this machine's previous fixers had tried to maximise the CPU's heat dissipation by tipping the scales towards low compound coverage. There was a thin sliver, but rather like the butter in a British Rail sandwich, I could feel it more than see it.

Before I put everything back together, I took the machine outside and hit it with the DataVac ED-500 (**tinyurl.com/373datavac**), removing a considerable buildup of dust in the GPU. Remember, if you use compressed air to clean your PC, take time to arrest any fans from spinning, particularly in the PSU. Use a plastic spudger or even a wooden chip-fork, to stop the air spinning the fan so hard

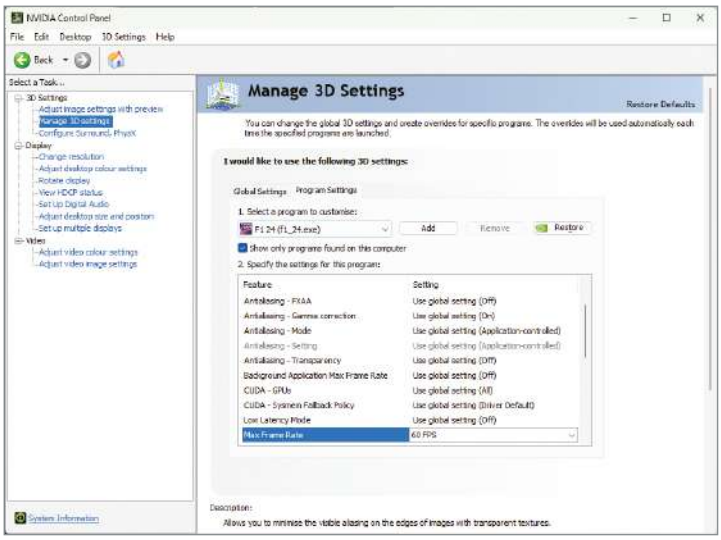
that the bearings become damaged. Your ears can thank me later. Once I'd cleaned that up, applied the correct amount of compound (*see issue 333, p115*) and nailed everything back together, I turned it on.

AS I'VE MENTIONED, HP OMENS ARE LOUD MACHINES, ESPECIALLY WHEN THEY'RE UNDER LOAD AND THE MOMENT I FIRED UP THE *F1* GAME, I THOUGHT MY TEETH WERE GOING TO DROP OUT. WITHOUT FEAR FOR MY OWN SAFETY, I KISSED MY CHILDREN GOODBYE THEN REMOVED THE SIDE PANEL AND DEDUCED THAT IT WAS THE THREE-FAN GRAPHICS CARD THAT WAS COMPLAINING THE MOST. I QUIT THE GAME AND THE OMEN RETUrned to volume levels which stopped me from passing out.

The GPU, an Nvidia 4080, had been specifically selected to play this title, and looking at the "Recommended" system requirements, it was a good choice. In the game, the graphic settings were set to Ultra level, but if I dropped things down to a lower level, the machine retained Omen levels of quietness. Deep in the game's settings, I couldn't find the magic tweak to keep the machine happy when I reverted to Ultra. Although a solution was to tell the owner to drop the game's settings, that's a bitter pill for someone who's spent north of £800 on a graphics card.

After a little research, I discovered my customer wasn't the only *F1 24* player with this issue. The consensus seemed to be that *F1 24*'s Ultra mode drives the hardware performance without limits. The system will give a zero-compromise "pedal to the metal" experience, which explains why the machine is so noisy.

The solution was to slow down the GPU, not from the game, but via the Nvidia Control Panel. This software, used by all Nvidia graphics chips, has a useful feature where overrides can be created for all or specific programs. In the 3D settings for *F1 24*, I throttled the Maximum Frame Rate to 60fps, so now matter how hard the game pushed the RTX 4080, there was now a barrier to limit the performance.


NVIDIA Control Panel
File Edit Desktop 3D Settings Help
Back
Select a Task...
3D Settings
Adjust image settings with preview
Manage 3D settings
Configure Surround, PhysX
Display
Change resolution
Adjust desktop colour settings
Rotate display
View HDCP status
Set up Digital Audio
Adjust desktop size and position
Set up multiple displays
Video
Adjust video colour settings
Adjust video image settings
System Information
Manage 3D Settings
Restore Defaults
You can change the global 3D settings and create overrides for specific programs. The overrides will be used automatically each time the specified programs are launched.
I would like to use the following 3D settings:
Global Settings Program Settings
1. Select a program to customise:
F1 24 (f1_24.exe)
Add
Remove
Restore
Show only programs found on this computer
2. Specify the settings for this program:
Feature
Setting
Antialiasing - FXAA
Use global setting (Off)
Antialiasing - Gamma correction
Use global setting (On)
Antialiasing - Mode
Use global setting (Application-controlled)
Antialiasing - Setting
Use global setting (Application-controlled)
Antialiasing - Transparency
Use global setting (Off)
Background Application Max Frame Rate
Use global setting (Off)
CUDA - GPUs
Use global setting (All)
CUDA - System Fallback Policy
Use global setting (Driver Default)
Low Latency Mode
Use global setting (Off)
Max Frame Rate
60 FPS
Description:
Allows you to minimise the visible aliasing on the edges of images with transparent textures.

I launched the game and it remained quiet (Omen-style), with perfectly healthy temperatures.

I gave the customer the instructions on how to tweak the settings, so they could try to match the game's FPS with the refresh rate of their monitor. After a week, a call was received to say that all was well, so if you're having a quirk while playing games with an Nvidia card, a tweak of the Control Panel may be the answer.

Acer: an apology

A few months ago (*see issue 370, p113*) I bemoaned the overly complex farce of swapping the fans on an Acer Predator laptop. When another Acer Predator arrived in the shop a few weeks later, also with a noisy fan, I gave the owner a rough idea of how I expected this repair to play out.

The specs on the two machines were virtually identical. Both were 2022 machines, with Smith-Gen i7's, RTX 3070s and 32GB of RAM, but this model was a Triton 300, whereas the nightmare from issue 370 was a Triton 500. The technical differences between the units are that the power draw of the components in the 500 are more than in the 300. In the unfathomable world of laptop model numbers, there's an expectation that a 500 series will be "better" than a 300, which is true in nearly all aspects bar repair.

ABOVE The Nvidia Control Panel lets you override settings in specific games

"In terms of excitement, it doesn't get any better for fan fans"

BELOW Acer's Triton 300 Predator is far easier to repair than the Triton 500

The 500 had required a near-complete dismantling just to access the fans, and it was a repair path littered with machine-wrecking traps. Inside the 300, the fans could be easily lifted by removing two standard screws and a bit of thermal tape. They allowed easy access to clean the inside of the laptop, but the 300 had other surprises. The fan units had micro-screws, which could be removed to get access to the blades, and these could also be lifted to reveal the fan's spindle. In terms of excitement, it doesn't get any better for fan fans.

Wrapped around this spindle was a long, wiry hair, which I later discovered belonged to the family dog (now deceased), so this straggler had taken some considerable time to work itself into a position to cause trouble. I cleaned the fans, lubricated with a tiny drop of 3-in-1 oil, and put it back together. So excited was I by the 300's design, I also removed the second fan for a clean and lube. Once the fans were back in, I replaced Acer's thermal tape with Red Wolf (**tinyurl.com/373redwolf**), an excellent cloth-tape which is non-conductive and heat-resistant up to 105°C, then fired it up. The fans spun, but you'd have to get very close to hear them.

It would be interesting to know why the ease of repair of the Triton 300 wasn't replicated for the 500. They're both from the same era and with virtually identical specifications, but only Acer could say if the same team designed them. So congratulations Acer on making a serviceable Predator – now do the decent thing and roll this out to every laptop you sell.

"Ripe for Vista"

Over the last few issues, I realise that I've complained about the lack of spare parts from certain manufacturers. When I was presented with a Dell laptop, I knew that this wouldn't be an issue. It was a Dell

Latitude D630, a great little machine that the owner had purchased because of its three-year warranty. Sadly, this expired in 2011 as the machine had been bought back in 2008 when Obama was president and Bowie had yet to release his final album.

This machine was an Intel Core 2 Duo, and although the top case had a sticker boasting "Ripe for Vista", the underside Windows licence sticker showed it had been through a paid-for upgrade to Windows 7 before getting a free transfer to 10. This Dell had spanned four generations of operating system, which is mighty impressive. It had been brought in because it wouldn't turn on, not to have the right-hand hinge fixed. Apparently, that had snapped several years ago and no-one seemed concerned enough to get things fixed.

Clearly this machine won't upgrade to Windows 11, so it's supported life is ending. Was it worth fixing? Should I kill off a machine which has seen so much history? Was I going to, as royal parlance has it, "inflict a Liz Truss on Ma'am?" Of course not.

The owner was clearly a techie of vintage and therefore knew exactly what they wanted, and none of that had anything to do with Microsoft, EOL dates, system specs or AI. Sorry Satya, you may wow a Wall Street trading floor, but your success rate with certain Yorkshire pensioners is nowt but a load of codswallop.

The fault was straightforward. The flexible plastic moulding of the power button had failed after 16 years of use, and although I could have sourced a replacement, it too would have the same fragility as it would be of a similar vintage. All that was required was glue, tweezers, Kapton tape (**tinyurl.com/373kapton**) and a childhood heavily influenced by Tony Hart. As they say around here, "That'll not budge nowt".

Conversion calamity

Two of the suggestions in last month's "End of Windows 10" feature (*see issue 372, p26*) concerned upgrading certain components to skip the hardware requirements and how to flip between different partition types. A few weeks ago, a job requiring both techniques was brought in. The machine was a 2014 Dell OptiPlex desktop, vintage in computer years but, as is often the case, still fulfilling the job for which it was purchased.

ABOVE The 2008 Dell laptop still going strong thanks to some glue and sticky tape

The discussion with the customer focused on what could be reused, but because of the bespoke PSU, motherboard connections and front panel pins, the wise decision was made to keep only the optical drive and the SSD. Interestingly, we don't fit optical drives as standard to our builds, only if requested. The percentage of users that have requested DVD or Blu-ray drives within the past year is 97.6%.

The trick with this build was to move the SSD to a new machine, then sort out the software so there wasn't an explosion of blue screens and crashes. Transferring a live drive to a new machine is not something I do lightly. Although Windows is quite forgiving with alien hardware these days, it's always advisable to make a clone before calamity strikes.

After the third boot attempt failed miserably, I interrogated the original drive and realised that Dell had shipped it with an MBR partition. I re-enabled CSM (or Legacy) mode on the motherboard and the machine booted into Windows 10.

Once I'd shuffled the old system drivers out and brought in the replacements, I was ready to take the "new" machine to Windows 11. This process requires converting the MBR partition to GPT, but fortunately Microsoft has a utility to sort this out: MBR2GPT. I suspect it must have exhausted itself on the snappily accurate name, as the tool itself is an unfriendly command line affair.

"Sorry Satya, your success rate with Yorkshire pensioners is nowt but a load of codswallop"

I opened CMD and began the conversion. It failed. I tried a few other methods, which also coughed. I went through the usual routine of checking partition sizes and still it wouldn't convert. Unhelpfully, MBR2GPT doesn't give any clues why it failed, just "Error: 0x00000000". After trying a different method via USB, an error regarding "partition type 222" appeared. "222" is a decimal number that converts to DE in hex. Older Dell machines used 0xDE as their Partition ID for the built-in Recovery Function and, to save us all a lot of painful explanation, MBR2GPT isn't smart enough to deal with 0xDE without help. The trick is to modify the command string so that the Dell Recovery Partition is mapped to a Basic disk GUID during the conversion process. As I've seen a raised hand at the back, here is the command for all the "old Dellers" out there:

****mbr2gpt.exe /convert /disk:0 /map:222=ebd0a0a2-b9e5-4433-87c0-68b6b72699c7 /allowFullOS**.**

Once complete, I could switch off legacy mode, boot Windows 10 and upgrade to Windows 11. If you wondered why I said MBR2GPT was unfriendly, now you know.

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Administrator: Command Prompt
MBR2GPT: Trying to shrink the OS partition
MBR2GPT: Creating the EFI system partition
MBR2GPT: Installing the new boot files
MBR2GPT: Performing the layout conversion
Cannot perform layout conversion. Error: 0x00000000
MBR2GPT-undo: Removing the EFI system partition
MBR2GPT-undo: Extending back the OS partition
MBR2GPT: Conversion failed
C:\WINDOWS\system32>mbr2gpt.exe /convert /disk:0 /map:222=ebd0a0a2-b9e5-4433-87c0-68b6b72699c7 /allowFullOS
MBR2GPT will now attempt to convert disk 0.
If conversion is successful the disk can only be booted in GPT mode.
These changes cannot be undone!
MBR2GPT: Attempting to convert disk 0
MBR2GPT: Retrieving layout of disk
MBR2GPT: Validating layout, disk sector size is: 512 bytes
MBR2GPT: Trying to shrink the OS partition
MBR2GPT: Creating the EFI system partition
MBR2GPT: Installing the new boot files
MBR2GPT: Performing the layout conversion
MBR2GPT: Migrating default boot entry
MBR2GPT: Fixing drive letter mapping
MBR2GPT: Conversion completed successfully
Call WinReRepair to repair WinRE
MBR2GPT: Failed to update ReAgent.xml, please try to manually disable and enable WinRE.
MBR2GPT: Before the new system can boot properly you need to switch the firmware to boot to UEFI mode!
C:\WINDOWS\system32>

BELOW Command and conquer: the rather unfriendly MBR2GPT

OLIVIA WHITCROFT

"When I awoke, my post had over 100 reactions. Had I finally reached influencer status?"

A new data act clarifies many aspects of the law, but questions remain in a number of areas, as *PC Pro*'s newest influencer explains

I've never had as much engagement with my social media posts as I did when the Data Use and Access Act 2025 (DUA Act) received Royal Assent on 19 June. After waiting since Brexit and the government's 2021 consultation paper (Data: A New Direction) to find out which changes were coming, this was top news. I was delivering data protection training during the day so shared the excitement with delegates, but it wasn't until that evening that I posted on LinkedIn about the new law.

I don't use LinkedIn a lot, and I'm usually happy if I get a handful of likes. Last time I posted about the DUA Bill (as it then was), it had eight reactions and six comments. But when I awoke the next morning, my post had over 100 reactions and several comments. Had I finally reached influencer status? At last, the world was as enthused as me about data protection!

In my eagerness to share the news I hadn't phrased my opening line as well as I could, and someone had said it wasn't actually a new data protection law; it was a modification to existing law. And that's an important point. The DUA Act doesn't create an entirely new data protection regime. It amends the UK GDPR and the Data Protection Act 2018 (DPA), so we need to read it in that context. Down the line we won't be referring to sections of the DUA Act, but the new or amended sections of the UK GDPR and the DPA.

As I had hinted at in my post, it also isn't just about personal data. The Act makes reforms in relation to privacy and electronic communications (including direct marketing and cookies), smart data and digital verification services. It also tiptoes into copyright and AI, which received last-minute attention as the near-final Bill ping-ponged between the House of Commons and the House of Lords.

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"At last, the world was as enthused as me about data protection!"

BELOW Who'd have thought that a post on data protection would go viral?

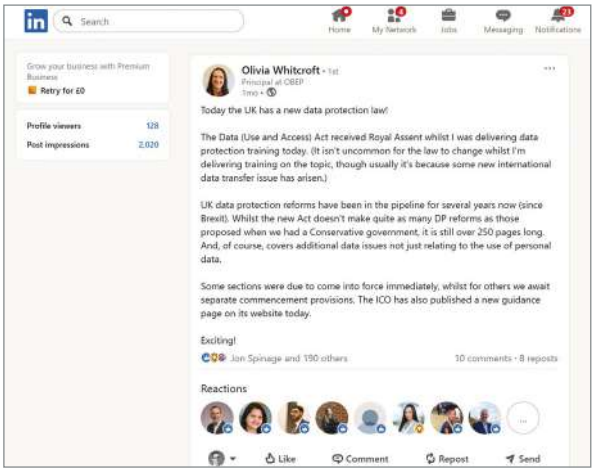
Some provisions came into effect immediately or in August, but, as I write, we still await commencement of the remaining provisions, expected over the next few months.

I talked about subject access requests in issue 369 of *PC Pro*, so have pulled out some other hot topics to tell you about here: international data transfers, automated decision-making and training of AI.

International data transfers

Schedules 7 to 9 of the DUA Act contain a lot of stuff on one of my favourite subjects: international data transfers. The government previously said the purpose of the changes was to allow a risk-based and flexible approach to transfers. But the provisions seem to focus on structural and linguistic modifications, rather than changing the key transfer mechanisms. One might wonder why they bothered to add 20 pages to the Act.

On more careful consideration, some potentially significant points emerge. There's a new "data protection test", which both the government and organisations must consider before making decisions on whether to allow transfers to non-UK countries. For organisations, this appears to embed transfer risk assessments (TRAs, arising from the Schrems II case) into legislation.


Search
Home
My Network
Jobs
Messaging
Notifications
Grow your business with Premium Business
Retry for £0
Profile viewers 128
Post impressions 2,020
Olivia Whitcroft
Principal at OBEP
Today the UK has a new data protection law!
The Data (Use and Access) Act received Royal Assent whilst I was delivering data protection training today. (It isn't uncommon for the law to change whilst I'm delivering training on the topic, though usually it's because some new international data transfer issue has arisen.)
UK data protection reforms have been in the pipeline for several years now (since Brexit). Whilst the new Act doesn't make quite as many DP reforms as those proposed when we had a Conservative government, it is still over 250 pages long. And, of course, covers additional data issues not just relating to the use of personal data.
Some sections were due to come into force immediately, whilst for others we await separate commencement provisions. The ICO has also published a new guidance page on its website today.
Exciting!
Jon Spinage and 190 others
10 comments · 8 reposts
Reactions
Like
Comment
Repost
Send

Under current law, the aim of the rules is to ensure that, when an international transfer is made, the level of protection for individuals is "not undermined" (Article 44 UK GDPR), and a non-UK country may be deemed adequate if the level of protection is "essentially equivalent" to that within the UK (or EU, as originally drafted – Recital 104 GDPR). The ICO's guidance on TRAs refers to people being in a "sufficiently similar" position in relation to the risks. The new data protection test requires the standard of protection to be "not materially lower" than in the UK.

What does this change mean? Is "not materially lower" different to "essentially equivalent" and "sufficiently similar", or is it just a new synonym stripped of the satisfying alliteration?

Also of note is that the data exporter must act "reasonably and proportionately" in determining whether the test is met. This may take into account the circumstances or likely circumstances of the transfer, including the nature and volume of personal data transferred. For those using the ICO's template for their TRAs, these factors are already built into the assessment.

So the practical impacts of these changes are not immediately clear. The UK's status as a country with adequate data protection laws is set to be reviewed by the EU in December, and I expect these data transfer changes will be scrutinised in deciding whether transfers into the UK from the EU continue to be permitted. I'll be interested in the EU's views on whether "not materially lower" is essentially equivalent to "essentially equivalent".

Early signs are positive. On 22 July, the EU Commission published a draft renewal of its adequacy decision for data transfers to the UK, indicating that UK data protection law, as amended by the DUA Act (including changes relating to data transfers, automated decision-making and research) continues to ensure a level of protection essentially equivalent to that in the EU.

Automated decision-making

The DUA Act significantly relaxes the rules on automated decision-making. Currently, under Article 22 UK GDPR, the rules are phrased as a prohibition. In short, subject to some exceptions, it isn't permitted for a software algorithm by itself to make a significant decision about an individual. Such decisions may relate to credit applications,

access to medical treatment or setting of insurance premiums, for instance.

I've also had many conversations about automated decisions in recruitment and employment matters. AI or other algorithms may be used to sift through large quantities of applications for a role, or analyse data for monitoring staff performance. Safeguards are often built in (such as allowing requests for human review), but it can be a hurdle identifying an exception to the prohibition. As I touched on in my article on lawful basis in issue 361, to be permitted, the automated decision must be necessary for entering into or performance of a contract with the individual, required or authorised by law, or based on the individual's explicit consent.

It's hard to argue that using AI to screen a CV is necessary for an employment contract, before the application is discarded without a human ever looking at it. At that stage, the contract is more a glint in the milkman's eye than something you're about to enter into. And, for an existing employee, can you demonstrate that the automated decision is necessary for the employment contract? There are some contexts in which automated decisions may be a good way to achieve something required by law, such as detecting fraud, but these are likely to be rarer.

That means we're left with explicit consent. But giving applicants or employees a genuine choice isn't as easy as it sounds. People may say yes just to stay on-side with you, or you may not really have a good alternative for someone who says no.

Under the new rules, the main prohibition will be for solely automated decisions based on special category data (such as information about health or ethnic origin), or that rely on a new lawful basis of "recognised legitimate interest" (also discussed in issue 361). For those based on special category data, there will be similar exceptions, with an additional public interest condition if explicit consent is not given. Safeguards must still be in place for all significant automated decisions, including explaining what you are doing and allowing individuals to contest the decision.

So we can get back on track with the law by considering other bases for automated decisions; in particular, "necessary for legitimate interests" (note this is different to recognised legitimate interest). We still have some points to check, though: is it a proportionate approach in context, such as a practical way to review thousands of CVs? Are the algorithms fair, and have risks of bias been mitigated in training of AI? Are individuals' rights protected? For example, have you told them it is happening, and can they challenge the decision? If yes to all of these, then my head can finally stop spinning in trying to find a lawful way for organisations to do increasingly commonplace activities.

AI, copyright and research

The AI and copyright issue bounced back and forth between the House of Commons and the House of Lords for the final few weeks of the DUA Bill. With references to *Groundhog Day* and *Macbeth*, the Hansard reports are quite fun to read. The Lords thought it a good opportunity to address this data-related issue within the data-related Bill. However, the Commons didn't think the Bill was the right place to tackle this matter and rejected the Lords' provisions several times. The Act ended up with some woolly obligations for an economic impact assessment on the options for changes to copyright law from the government's 2024 AI and copyright consultation (*see issue 369, p116*) and a report on the development of AI systems, such as technical measures to control use of copyright works.

The Lords had wanted to include transparency obligations in the use of works to train models, so that copyright law can be enforced where needed. They also sought to address a jurisdictional point, so that AI models trained or developed overseas but marketed in the UK or with significant UK users should comply with UK copyright law. These debates were happening alongside the *Getty Images v Stability AI* High Court case (*see issue 372, p116*). A key issue was – you got it – whether training of Stability AI's Stable Diffusion model took place inside or outside the UK and the extent to which UK copyright law applied. The key copyright claims were subsequently dropped due to a lack of evidence on this. Gah!

ABOVE **It remains unclear whether the training of AI counts as scientific research**

"The changes to automated decision-making rules have saved my head some spinning"

BELOW **The House of Lords tried to address the AI/copyright issue in the DUA Bill**

A related but less well-publicised debate on the DUA Bill concerned changes to the research provisions of data protection law. The re-use of personal data for scientific research is considered compatible with the purposes of collection, which means no additional consent is needed from individuals. The DUA Act clarifies that both commercial and non-commercial activities can be scientific research. The House of Lords was concerned that personal data may be scraped to train AI under the heading of "scientific research", so proposed that the research should have a public benefit, too. This was also ultimately rejected, and the final wording leaves us with the question of whether training of AI is research that could "reasonably be described as scientific".

Where does this get us?

The changes to automated decision-making rules have saved my head some spinning, but we aren't yet clearer on the practicalities of applying UK copyright law to the training of AI. And it seems my head can keep spinning for a bit on the meaning of "not materially lower" for international data transfers, and in what circumstances describing something as scientific research may be deemed "reasonable".

On a brighter note, as I write this, my LinkedIn post on the DUA Act has 191 reactions. I'm sure by the time this article is published it will have reached even dizzier heights, firmly establishing my pico-influencer status.

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DAVEY WINDER

"Ransomware is an extortion racket, and the people behind it are as caring as the Kray twins"

Guilty: it's another column about ransomware, but this one is different as Davey asks whether the government is right to ban ransom payments

Given the mass media coverage of ransomware attacks on first the UK high street and then the US retail sector, you'd be forgiven for thinking that ransomware is public cyber enemy number one. Now, don't get me wrong, it's a massive problem that has enormous potential for harm to business, but it's far from the only thing you should be focused on. Especially when you realise that rather than being on the rise, ransomware is actually in decline.

I'm not talking about the fall of major criminal groups that have dominated the threat sector in the past; they're always replaced by others or by themselves. The disbanded groups splinter and make new alliances, form new groups or simply change their name, tweak the malware, establish new infrastructure and it's business as usual. Take the example of the ransomware group behind those attacks on Marks and Sparks and the Co-op: Scattered Spider, or more loosely The.Com collective, which emerged after the fall of ALPHV (Black Cat).

No, what I'm talking about is a decline in the threat itself. NCC Group (**nccgroupplc.com**) publishes a monthly "Threat Pulse" that demonstrates this using cold, hard, real-world facts. The June 2025 review was the latest available as I write this, and it found that in Q2 of the year, ransomware attacks have fallen by 43% compared to the first quarter. While the vast majority (79%) of the attacks that did happen targeted Europe and North America, the decline has been attributed to a combination of religious holidays and increased law enforcement disruption. Europe, however, had fewer than half the attacks recorded across North America, representing an 8% drop in June.

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"Rather than being on the rise, ransomware is actually in decline"

Where things get really interesting is when you look at the industry sectors where these attacks were happening. Attacks on retail – part of what is collectively measured as the "consumer discretionary" sector by NCC Group – dropped by 25% as Scattered Spider activity fell, most likely due to increased global law enforcement attention. Retail remained in second place, though, behind industrials and ahead of healthcare (the absolute bastards!) and information technology. With Scattered Spider taking a breather, Qilin became the most prolific ransomware actor, responsible for 16% of all attacks in June. This could be down to it offering legal assistance to its affiliates to navigate law enforcement risks, NCC Group said, and improving negotiations to pressure victims to pay up, making it more appealing to work with.

Here's the important bit: "The volume of victims being exposed on Ransomware leak sites might be declining but this doesn't mean threats are reduced," said Matt Hull, global head of threat intelligence at NCC Group. "Law enforcement crackdowns and leaked ransomware source code is possibly a contributing factor as to a drop in activity, but ransomware groups are using this opportunity to evolve through rebranding and the use of advanced social engineering tactics."

Which brings me nicely to the point of this sojourn into statistics city: the British government has announced that it's going to ban ransomware payments by organisations in the public sector and those involved with critical national infrastructure. This, unsurprisingly, has created something of a cyber-industry furore. There are loud voices on both sides of the ban ransom argument, and there always have been, but I think it deserves a less emotional and more analytical approach to determining if it could work or not, don't you? Okay, let's give it a go then.

What is the government actually proposing?

Obviously, if you want the complete picture of the proposals you should read the full consultation and resulting documents, which you can find at **tinyurl.com/373consult**. If, however, you're a normal human being and don't want to give yourself a migraine, the AI-in-a-meatbox that is me can help.

Following what it describes as an extensive consultation process, the government has decided it will be cracking down on ransomware actors by banning public sector bodies and national critical infrastructure providers from paying ransom demands. Think the NHS, schools and your council. Any organisation not covered by the legislation would still be required to "notify the government of any intent to pay a ransom" and could be informed they would be breaking the law if the ransomware actor is part of a sanctioned criminal group, as many based out of Russia are.

BELOW High-profile attacks on the Co-op and M&S brought ransomware to the media's attention

Arguments for the ransom ban

I'm not as convinced as Scott Walker, manager of the Computer Security Incident Response Team at Orange Cyberdefense, who told me that the new measures "are, without a doubt, the correct move" and "exactly what the industry has been waiting for from the upcoming Cyber Security and Resilience Bill (CSRB): a new ransomware

payment prevention scheme, and an enhanced ransomware instant reporting regime".

However, Walker makes compelling arguments for the strategy, not least that cybercriminals are not to be trusted. "There is a common myth I have heard often: ransomware groups are like businesses that want good reviews and will help you if you pay. In reality, most attackers have an aggressive disdain for victims and see them as merely collateral in their pursuit of a payday, providing little or no support once paid." He's not wrong; ransomware is just a modern-day extortion racket, and the people behind it are as caring as the Kray twins were back in the day.

But this alone is not enough to be supportive of the legislation; there's a bigger picture. Namely that it is imperative that both the public sector and CNI providers become less attractive targets for attackers. Okay, you can argue that this is best achieved by making them impossible to attack but, as we all know, that is an impossibility. Repeat after me. There. Is. No. Such. Thing. As. 100%. Secure.

Although not all cyberattacks are driven by money, I'd be gobsmacked if anyone could convince me that anything less than 99.9% of ransomware attacks are. Take the financial benefit away, and the criminal groups behind the attacks will move to pastures new. Of course, that raises the questions of what and where these pastures will be located, but more of that in the arguments against section, methinks.

Perhaps focusing too much on the ransom ban itself is the wrong thing to do here anyway. The legislation also talks of making it a requirement for *all* organisations to make a mandatory disclosure if a ransom is being considered for payment. To me, that seems like the much bigger story here. It's not as big a leap as mandatory ransomware attack reporting across all sectors and organisations would be, but anything that can both help paint a better national threat intelligence picture and deter payments (just think about the likelihood of reputational damage and legal exposure as well as government pressure) might not be a bad thing.

Finally, I should mention that, while not being a legislative requirement, law enforcement advice is already not to engage in ransom payment negotiations. That doing so helps drive further cybercrime (and quite likely other forms of crime), which means that the government plans are a logical next step. Not every organisation, every business, will be impacted by the ransom payment ban; it's important to remember that as well.

Arguments against

At least in the short term, I have to admit that I am concerned that the legislation could be more problematic for victims of ransomware rather than the perpetrators. Nobody wants to pay a ransom, but if the business's profitability, or even continued viability, is on the line, then the question has to be: what other choice is there?

I've made this argument many times before, and I stick to it: paying ransoms is not a good thing, but not being allowed to pay a ransom and go bust instead is even worse. The threat actors – career cybercriminals, let's not forget – aren't going to shrug and go look for a job in Starbucks. They will continue targeting organisations in other countries without such a law, or move to other nefarious ways to make money. This will not be the mythical magic bullet some appear to imagine it must be.

"The issue with the UK's approach," Tj McClearin, CEO of Xcape, told me, is that it "leaves some low hanging fruit with organisations that are in a particular sector or of a smaller size, leaving them the vulnerable targets." Criminals are lazy bastards, otherwise they would work for a living like everyone else. Low hanging fruit is of the greatest appeal, and businesses not on the government list are precisely the ones less likely to have protections in place to start with. They're the least likely to have the resources to survive a ransomware attack without paying "something".

RANSOMWARE ATTACK
Your personal files are encrypted
You have 5 days to submit the payment!!!
To retrieve the Private key you need to pay
Your files will be lost

ABOVE **Ransom payments are to be made illegal in the UK**

"This will not be the mythical magic bullet some appear to imagine it must be"

Rather than look for ransoms, does anyone else think that the threat actors might just turn to the sensitive data that is exfiltrated in almost every ransomware attack these days and monetise that directly instead? You know, selling it to the highest bidder? Packaging it for sale to other threat actors? The list of possibilities to profit is almost endless, and the only people losing out are the impacted organisation and, more importantly, their customers, clients, patients, whatever.

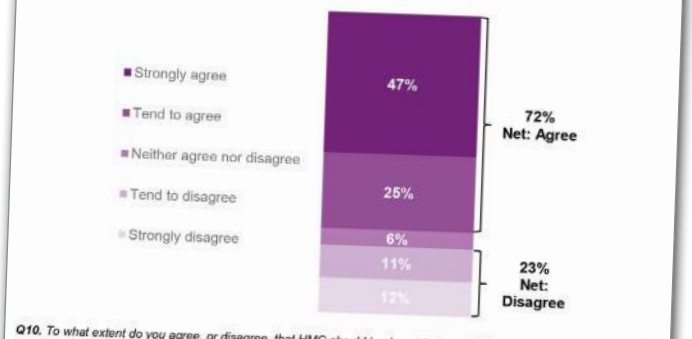
It's not often that I agree with a Forrester bod, but I'll make an exception when it comes to principal analyst Allie Mellen. She said that "while banning organisations from providing ransomware payouts sounds good in theory, it is a disaster in practice". This is the big issue with such stances; they look great on paper but in the real world they can often be nothing less than victim-shaming and, as could well be the case here, compound victim losses.

"While it's unfortunate that ransomware payouts happen, the better effort should be spent on supporting organisations in protecting against these kinds of attacks," Mellen told me. Dammit! I'm agreeing again. Three times is the charm: "We absolutely recommend discouraging paying the ransom, but to ban it outright is unrealistic and detrimental to the organisations they look to protect."

It is also, I should add, far from clear as to how managed service providers – you know, the platforms that are relied upon so heavily by so many

BELOW **Government consultations showed overwhelming support for the ban**

Figure 3: Agreement levels for implementing a targeted ban on ransomware payments for CNI owners and operators and the public sector



*Q10. To what extent do you agree, or disagree, that HMG should implement a targeted ban on ransomware payments for CNI owners and operators (who are regulated/have competent authorities) and the public sector, including local government? **Base** = all respondents (n=231)*

Continued from previous page

public sector bodies in both healthcare and education – will be impacted by the legislation. My take on it is that they wouldn't be included in the no ransom instruction, yet they have and will continue to be targeted by ransomware actors. Those attacks will continue to impact both the aforementioned sectors, so how is the ban actually going to help in practical terms?

And finally, a good point made by someone I commonly turn to for advice in such matters: Boris Cipot, senior security engineer at Black Duck. "Another thing to also consider is that most of the ransom requests are not in millions but are often a few thousand pounds." These are low enough to fall off the media radar, small enough to make paying the ransom a no-brainer against the loss of data and business continuity.

If you really want to put a stop to ransomware, then make it harder for them to attack in the first place, not harder for victims to escape their clutches. Put the money and effort into better protecting businesses, making it easier for them to deploy what are often costly processes. Provide grants, do something; whatever it takes without making the victim the bad guy in the scenario.

So, are the ransom bans a good or bad thing?

It is, as always, too soon to say. The proof will be in the eating of the cyber pudding. My gut tells me that we will see ransomware payments moving underground, out of the media spotlight, with organisations willing to take the risk of falling foul of mandatory reporting rather than taking the financial hit or going out of business. Desperate people will always find a way around such legislation. That's just a fact.

If, on the other hand, this move means that there's a bigger push towards getting preventative measures into place, deploying incident response plans that are actually stress-tested and proven, so as to deal with the chance of falling victim, then maybe it's a good thing. I'll let you know in *PC Pro* issue 400 when the stats are in...

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STEVE CASSIDY

"I'm an evil system tester, thinking up software-breaking situations, and this occasion was no different"

What would life be like without Google if its services were unavailable due to a deliberate act of sabotage?

How can you get your people – employees, family, relatives – used to the idea that Google might not be available one day? Not just in a regional crash, but offline for days, weeks, months due to a deliberate act of sabotage?

That might have seemed a low risk just five years ago, but these days the world is very different. The need to be at least aware of what fault-tolerant options you can exercise has never been greater, and the emphasis on continuous access as a prerequisite for using cloud services never stronger.

Then there are the human factors. The uncomfortable need some people have for a sense of permanence – without any idea, naturally, as to how that permanence might be achieved, or what it depends on.

Quite by accident, I stumbled on an ideally sized case study this summer. In previous columns I've talked about the dangers posed by sub-sea fibre optic cable-cutting, and knowing who has been writing that quirky utility you love so much. But that's just the start. There are moody, unpredictable presidents, a variety of volcanoes itching to explode, or the literal blast from the past if you grew up in the Cold War: the prospect of a nuclear attack. These situations seem remote but consider the Icelandic eruption I'm not going to spell, any more than you are going to say, that disrupted our lives for a fortnight a few years ago. Anyone got a volcano simulator?

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"Petal Maps has been doing a kooky job of replacing Google Maps and Waze"

Not me, but I do have the Huawei Pura 80 Pro, the fifth generation of phone the Chinese giant has built outside the warm embrace of Android. This concept arose because the USA and Huawei had a falling-out, but it didn't take Huawei very long to produce a polished and oddly quite well-served phone ecosystem.

I have just set off on a European tour, and Petal Maps has been doing a kooky job of replacing Google Maps and Waze, a combination I've been reliant on for half a decade. Huawei's navigation app is chattier than Google's. When I hit the motorway it kept up the warnings about average speed zones, just like Waze does – but then on exiting a zone, the prim, Americanised voice told me what my average speed had been.

Nor was she quiet when spotting a change of speed limit: "50mph limit 600 metres ahead" she'd say, followed a forlorn "Please slow down". Other driving observations included "Junction ahead, expect traffic joining from the left" – something I'd hope most countries would handle in their driving tests, not leave to picking the right satnav a few decades later.

Petal Maps is pretty, too. Whatever map database is behind it comes out looking about as good as Bing Maps, but there's the rub: who created it? Evidently, it's not as independent from the western world as you might imagine. I got a message about updating traffic and route change info at Huawei's maps partner, which is revealed here as being... TomTom!

This brings me back to my earlier point of how to get your people to understand how quickly

BELOW Huawei has prospered outside Google's ecosystem

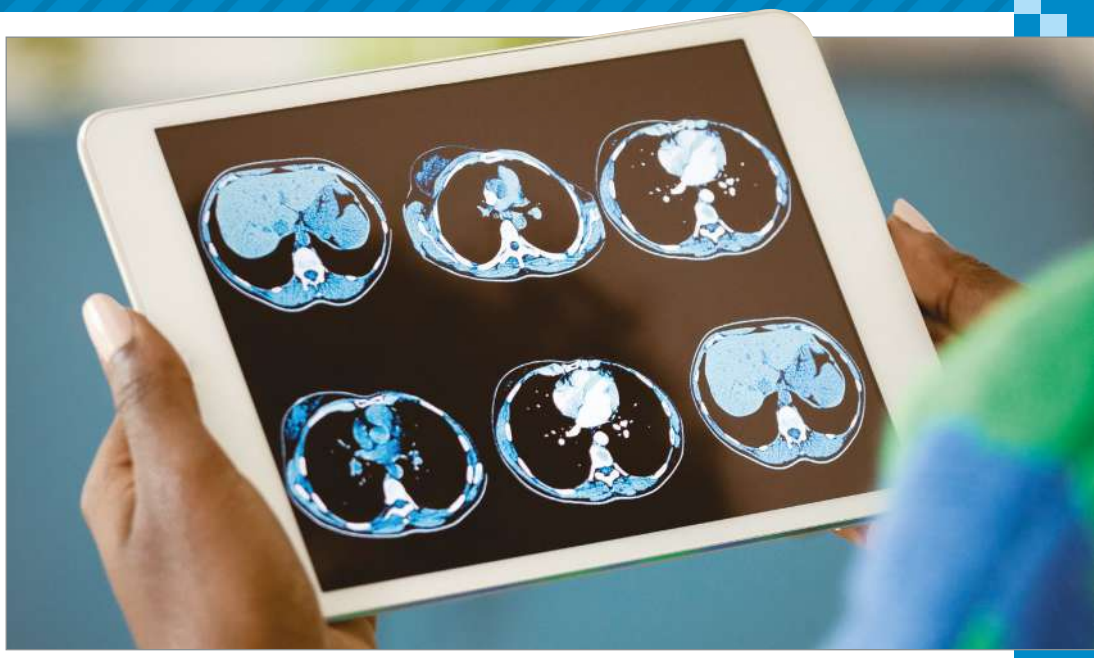
things could go south. Consider the day an unhinged president decides to charge a tariff on every byte crossing his borders; these backdoor deals between service providers sitting so quietly in the background could easily be snuffed out as a result.

Then again, the mix of software and developer resources for this anti-monopoly platform is better than I was expecting, perhaps because I wasn't expecting much. Imagine my surprise when I spotted Microsoft Edge in the Huawei AppGallery, and my delight when it turns out to have an ad-blocker built in to improve the experience of trying to watch YouTube in the browser.

I also came across a link that purported to deliver video players for Harmony OS, but which was plainly not hosted inside the app store at all. It quickly became clear this was a collection of smaller projects, each with their own objectives and some coming from exactly the places one might be trying to avoid using.

All that said, it's a very pretty device with some quite shocking pre-release estimates of the eventual RRP – £1,700, anyone? – but once you look at it as a tool with a business purpose in turbulent, unpredictable times, that price tag looks almost irrelevant. And I have to say, it does take a very nice photo.

ABOVE Petal Maps is a quirky yet excellent alternative to Google Maps



ABOVE AI could be an enormous benefit in the healthcare sector

Blown away by a single word

Regular readers may have figured out that I spent a bit of time in hospital in 2024. While I keep declaring it was "no big thing" and sparing the tender sensibilities of friends by avoiding any detailed descriptions, the truth is that it's taken a year for my injury to heal. From the start I was left in no doubt that I had dodged a bullet, and that the healing process would be protracted and occasionally unpleasant.

Since then, my situation has come to the attention of a dozen clinicians spread across five specialities in three different but neighbouring health authorities. Incredibly, even though I can walk from one health authority territory to another in a matter of minutes, each of these huge organisations has exercised its right to opt out of central NHS software package selection and operation, and as a result communication between the specialists has often come down to me or my carer being handed little scissor-cut rectangles of paper about a quarter the size of a banknote. These contain vital email addresses that act as information clearing-houses to lead the way out of this information non-distribution labyrinth. We were told, more than once, that we should under no circumstances divulge these addresses.

None of these clinicians could access cloud apps, either. Downloading anything like a client app to a medical workstation is grounds for dismissal. In the end I have carried my MRIs, X-rays and test results around on a USB key – which they're not supposed to plug in, either.

So my interest was already piqued when a press release turned up from the software house Tandem (**tandemhealth.ai**). Not related to the mini-computer company of the 1980s nor the PC manufacturer Tandon, the release claimed the usual 200 impossible things before breakfast for a relatively humble LLM-based patient data capture app aimed at GPs and admitting clinicians.

"You know you've had it bad when the MD-turned-developer starts to look a bit queasy"

Now, these are people who are already very bored with spending their time typing like demons into forms using a data-input process that's the direct opposite of how a typical Q&A-style diagnostic process normally operates. Most annoyingly, the physician has to make initial assumptions to fill in these classic composite documents, plumping for the right category in a drop-down list right up front long before they come up with the single, simple question which turns the whole process of disease identification upside down. I've always taken a dim view of input forms on web pages or apps that purport to be processing what you put into them, when actually they're just an inflexible series of assertions that oblige you to do the processing, simply to get round the pesky input validations.

This app, said Tandem, is different. Would I like a test run? I was even saved the bother of having to throw together some fictionalised patient with their sufficiently complicated mythical ailment, because I could just use my own history from the past couple of years.

Even though I kept the worst of my details secret, all I will say is that you know you've had it bad when the MD-turned-developer running the demo starts to look a bit pale and queasy. The idea was to chat away, as you might when consulting a new clinician. Something I'd had plenty of practice with. When discussing the whole arc of my experience, I like throwing in a few wry observations

here and there, like how it seems to be funny that my old dentist fell off his garage roof while messing with his smart lighting installation. I also like to drop in some basic stats from my most active cycling period, just to foreshorten any conversations about the usual "smoke, drink, what about hobbies?" lifestyle questions. This time I just said that I'd been a hardcore cyclist, something I hoped to get back to as soon as the wounds all healed up.

The LLM ghost in the machine took away our highly informal conversation and mulled it over for a few minutes. What came back was frankly incredible. I'm an evil system tester, thinking up software-breaking situations, and this occasion was no different. Using my history over the past year made for some authentic interview divagations: we rambled over the whole subject, and the fact is that at the end the summary had completely ditched the dentist on the roof bit, and retained "hardcore cyclist", putting it in the "social, sports and fitness" category.

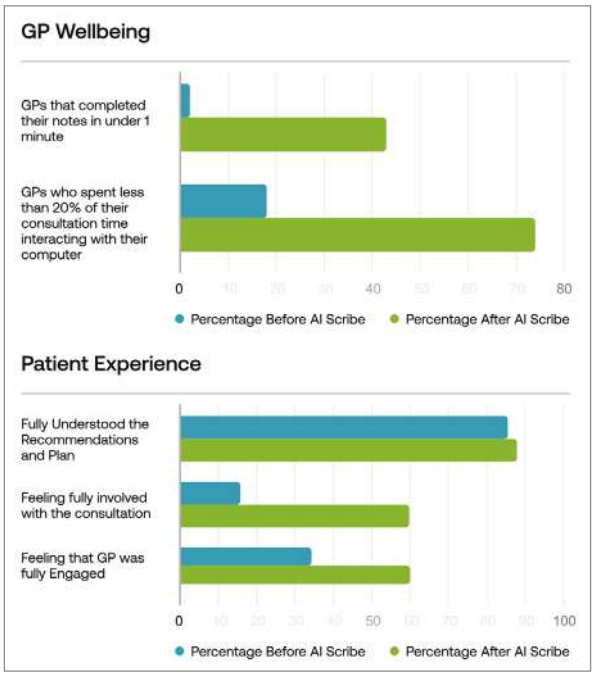
I was impressed, before moving rapidly into flabbergasted territory when the demo doctor said: "This is the surgical summary. Doctors love their jargon and their expertise-driven rules, and this can produce a nightmarish workload if the GP has to send reports off to several different specialities. The AI in this case can generate an expertise-specific summary at the click of a button, doing different template transformations on the same single central transcript." As he spoke he flipped the report through half a dozen different formats, for surgical guys, foot guys, diabetes guys, as quick as he could move the mouse.

This, he said, accounts for 30% of the time the app claims to save per week for GPs and hospital clinicians. I actually came across the concept of template-driven interaction a while back, in the context of preparing training materials for employees or customers; in this case the template is a mixture of layout and rules of precedence for various parts of a clinical picture, because the heart guys want the heart stuff on page one while the foot guys don't mind if it's on page three.

This is an aspect of AI that most of the punditry and coverage has forgotten. Give the machines something consisting of verified factual reporting and straightforward observation, and their latitude for emitting crap is taken away. This clinical summariser is constrained by some basic rules and requirements, some expressed in the code, others in the initial templates. With all that random freedom taken away, the AI decisions become less random, less a matter of tossing a coin on each re-run: indeed, the ability to re-run for different specialities becomes vital to the clinical outcome. Something I had certainly experienced this year as the list of involved parties grew to four health authorities (five if you include Boots) prescribing nine medications with at least four different sets of rules which frequently contradicted one another.

I'm somewhat miffed by the thought that we have been wasting a lot of intellectual time on mythological interpretations of what AI is and can do. To my mind, this type of guided-output application is a whole different category from your regular MLs, LLMs, etc. This isn't some *Doctor Who*-type global master brain: it's a servant AI, working silently and rapidly inside the Azure cloud platform. Its best day comes when the patient and the audience for the reports generated by their affliction are delivered and consumed without any extra comment about being on any kind of leading edge whatsoever. It looks like business as usual.

I don't know about you, but to me this is an area in which most business IT managers or proprietors are entirely missing out on. Just the IQ of the summariser alone is enough to get businesspeople thinking: how about turning those rambling calls that follow a fender-bender accident into a crisp couple of sheets of A4, with the underlying conversation kept for a while to allow reports suitable for lawyers, loss adjusters and third-party risk types to be called up at will? This represents a whole new way to do business, with messy human chit-chat as the entry point and crisp, business-ready summaries as the output.



ABOVE Tandem aims to slash the amount of time clinicians spend on diagnosis and data input

"This is an aspect of AI that most of the punditry and coverage has forgotten"

No AI has been left to make any decision in the domain of expertise. The usual criticism of "black box" stage magician-style decision-making, of different results with each re-run of the request, don't apply here, because the whole point of the system is that it has to be able to run the same input with a different output template and provably not suffer any crisis of belief on the part of the subject, the professional, or the recipient. No small task.

So yes, I like the demo. However, I'm reminded of the smart training template people I met in Salt Lake City a few years back. They didn't hook themselves so firmly to AI but they did freely acknowledge how hard the process of building a template of this type can be. It's another much more subtle case of the rules governing the cognitive load of building a set of templates to express an arbitrarily difficult, possibly not fully understood, field of expertise being much tougher and booby-trapped with hidden pitfalls than even the experts themselves may not anticipate.

I'm sure there are a lot of board members out there who think that supporting AI and having faith in the solution of difficult problems by "the computer" is the right strategy to follow. The problem for us is this: how can we show the faith-driven decision-maker the basis for deciding what's easy, and what's difficult? And that's what really got me excited about Tandem's approach to single transcript, multiple report templates, and re-run consistency in AI-driven output.

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Hubris in Tandem

I'm writing this in Germany, on hotel Wi-Fi. Tandem's website is so smart, it detects where I am and changes language accordingly. It is more than diligent: I literally cannot read its English language site while not in an English-speaking location. The little daemon of the site flips me back to local, every time. Full marks, guys, and HOW DO I TURN IT OFF?

Commodore: The comeback

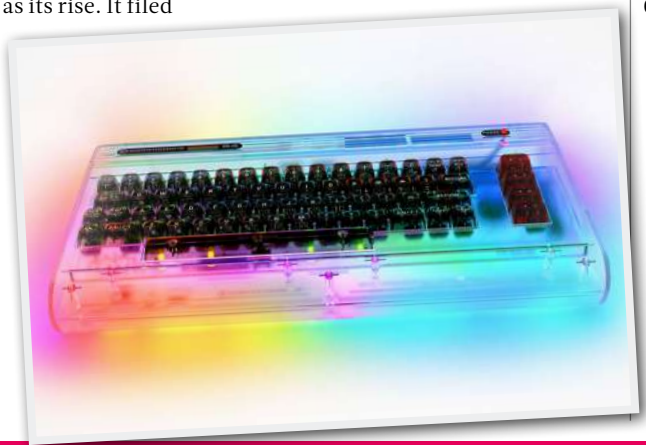
David Crookes looks at how a once powerful and influential tech brand hopes to shine once more, including an exclusive interview with Commodore's new owner

Commodore was once one of the world's biggest names in computing. In its golden years, it sold more computers than Apple, IBM and Atari. That success was founded on the 8-bit Commodore 64, the best-selling single computer model of all time, while the 16-bit Commodore Amiga is a legend in its own right. That machine was powerful enough to drive the visual effects for the popular sci-fi series *Babylon 5*.

But Commodore's fall came almost as rapidly as its rise. It filed for bankruptcy in 1994 and saw its liquidated assets sold to Escom, which went bust two years later. Bits of Commodore then ended up in lots of different hands, and it became increasingly difficult not only to work out who owned what but to figure out what Commodore actually represented.

Over the past three decades, you'll have found the name plastered on an eclectic range of products from the Commodore XX gaming PC and Commodore PET smartphone to LED lightbulbs and a personal multimedia player called Gravel in Pocket. Some devices have even been hits. Consider the Commodore 64 Direct-to-TV (C64DTV) plug-and-play joystick, initially sold by QVC in 2004, which shifted in the tens of thousands.

ABOVE Christian Simpson spearheaded the purchase of the Commodore brand



LEFT Commodore wants to be as transparent as the Starlight edition of the C64 Ultimate

LEFT The new Commodore 64 Ultimate looks exactly like the C64 that was launched in 1982

While the Commodore name has lost some of its lustre, people still remember its products fondly. Some companies have preferred to tap into the nostalgia of Commodore products without actually mentioning the name: Retro Games Ltd showed this to be the case with the launch of THEC64 Mini and THEA500 Mini, machines that used familiar model monikers instead.

So does that mean no-one cares for the Commodore brand any more, or has it simply been waiting for the right approach?

A fresh start

In June this year, a few months after he had stepped down from editing the Commodore 64-focused magazine *Zzap!64*, Christian "Perifractic" Simpson posted a YouTube video dubbed "Can We Save Commodore? My Biggest Project Yet!" His promise: to bring the Commodore brand back into the hands of fans and create new products.

Clearly passionate, Simpson spoke of his negotiations with the owners of Commodore Corporation B.V. – a company based in the Netherlands that was licensing the Commodore brand name – and ended the video with a tease. Simpson had received a message that showed his plan to seize control was very much within his grasp. "Yes, we can grant you an exclusive licence," the message said. "But your team seems to know Commodore better than we do. We might like to sell you the whole company."

Soon, Simpson was back. "As of a few weeks ago, I am the acting CEO of Commodore Corporation," he declared. "We have completed the acquisition of Commodore." As he spoke, the details of the deal became clearer. The price was "in the low seven figures" and it had been funded, in part by angel investors.

The team included Bil Herd, the principal engineer on the

Commodore Plus/4 and designer of the Commodore 128; Michael Tomczyk, the product manager for the VIC-20 computer; and a one-time Commodore tech support specialist called James Harrison. Not to mention David Pleasance, former joint managing director of Commodore 64, and Jeri Ellsworth, creator of the C64DTV.

"From Al Charpentier ('father of the C64') to Bil Herd to the former co-MDs of Commodore UK – each person brings history, expertise and heart," Simpson said. "I wanted to inject the DNA of the original Commodore into its reboot. Even Leonard Tramiel (son of Commodore's founder Jack) got involved, as our 'CTrO' (Chief Tramiel Officer).

There was one other surprising name on the team – that of Thomas Middleditch, who played Richard Hendricks in the HBO television series *Silicon Valley*. It turned out he grew up with an Amiga and soon became enthused.

"I was a huge fan of the show, and one of our investors mentioned that Thomas was now looking to invest in tech startups. Life imitates art, huh?" Simpson said. "So an email introduction was made, a Zoom call followed, and the rest is history. Thomas recounted to me his love of his childhood Commodore Amiga 500 that he had in the house since the age of five. His ideas are breathtakingly cool."

Ultimate dreams

This collective is now in a position to advise and support the new company while lending it a stronger link to the past. "It's not just a team. It's a reunion, and the passion behind this mission is contagious," Simpson told *PC Pro*. "We didn't just pitch a product. We pitched a movement. And many of these legends told me they'd been waiting for someone to 'do it right'."

Simpson, too, has a long, passionate history with Commodore computers. "I grew up with a C64 that we bought from Dixons, when I was around 12," he said. "It sparked my love of tech and creativity." He even licensed the brand for the 2011 launch of the Commodore 64x, a replica Windows/Linux PC in a Commodore 64 case.

TOP There are three varieties of Commodore 64 Ultimate on offer

ABOVE The names of C64 creators, past and present, are etched on the new motherboard

The revived Commodore is certainly wasting no time. It has relaunched the C64 as the Commodore 64 Ultimate, with the development team including Gideon Zweijtzer, an electronic engineer who developed the Ultimate-64: this is a complete C64 motherboard replacement replaced in 2018. Then there's Jim Drew, who wrote disk copy programs, while Jake Young has been creating and selling C64 cases and keyboard accessories at Retro Fuzion.

The Ultimate recreates the original motherboard on an AMD Xilinx Artix-7 FPGA. This allows it to simulate the C64 accurately rather than emulate it in software, and it comes with a flurry of modern touches, from a 1080p HDMI output, USB-A and USB-C ports, built-in Wi-Fi and 128MB of RAM – a far cry from the 64K offered in the 1980s.

It's available in three iterations. There's a BASIC Beige edition for £223 that looks like the original, a gold Founders Edition for £372, while £261 will buy the Starlight Edition, complete with gaudy LEDs. All these prices exclude taxes. Whichever you choose, you can connect original C64 peripherals, including a tape deck, disk drive and "dusty old cartridges". Games can also be played via a thumb drive, including the bundled drive that resembles a cassette. To quote the tagline for the machine: "Retro gaming. Modern power."

> "It's not just a team. It's a reunion, and the passion behind this mission is contagious"

Within the first week or so, around 4,200 Commodore 64 Ultimates had been sold, with the base model accounting for half those sales. Generating revenues of more than $1.5 million, it proves there's a strong appetite for revived machines. Nor is it alone: the third iteration of the ZX Spectrum Next computer on Kickstarter achieved roughly the same numbers within three days. But why?

Simpson says the Ultimate is proving to be attractive because it trades on authenticity and an enhanced experience. "Past reboots have been really cool emulators, but still emulators," Simpson said. "They do a fine job, but some people prefer authentic hardware. Part of that is 'knowing' that it's real, not software emulation. The other part is latency (how much a game may be delayed after pressing fire, for example).

"FPGA hardware like ours just runs faster as it's happening at the bare metal level, not in code. This is the real deal – a hardware recreation, modernised respectfully. There's so many cool touches we've added that have never been available before."

Long-lasting

Despite the strong start, a good number of sceptics remain. The main issue is that past attempts to revive Commodore as a company have failed to set the world alight. It doesn't help that ownership of the original company's assets are in different hands.

Some people have also pointed out that the target market, certainly as it stands, is sure to be limited. The Commodore 64 Ultimate is a niche product that primarily appeals to retro computer enthusiasts, but Simpson says plans are afoot that will

combine retro with futurism. That's reflected in the company's website, which states it is "Honouring the past. Innovating the future".

Simpson certainly understands he has a job on his hands. "I get it. There have been too many false starts. People have been rug-pulled by YouTubers before," he said. "But we're not here to sell nostalgia – we're here to earn it."

His aim is to create products that will linger long in the mind. "When people look back in 30 years, I want it to be our Commodore they're nostalgic for and I want it to still be there right next to them. That's my dream," he added.

"Our actions are already different: not many companies would be as transparent as we are through our crowdfund product launch, where we show exactly how many units of the Commodore 64 Ultimate have been preordered. We're building trust one step at a time. If you're sceptical, good. We'll prove it through execution, not words."

One thing he is keen not to foster is a "them and us" situation. There is a thriving community of enthusiasts keeping Commodore's past machines alive, from those who simply play games and invest in hardware to those who actively develop them. Such developments allow people to expand the capabilities of their computers and try something new. Simpson says the new company will seek to work with others, not against them.

"We're offering affordable licensing, promoting community mods, and partnering with key creators, all under quality control guidelines that protect the brand while empowering the makers," he said. "Think: open standards, trusted partners and fair royalties. We're not out to squash the little guy. We are the little guy! We came from the community, hence the hashtag #WeAreCommodore.

"People have been understandably worried that we'd do a Nintendo and go all lawyery on them, but that's just not in my spirit. If you're using the Commodore name harmlessly such as in your YouTube handle, that's cool. If you're using the branding to make a profit, we can support you with a place on our upcoming web shop to drive you more sales."

Making friends

Plans are also ongoing to work with those who own the rights to the Amiga. For instance, the director of Cloanto, Mike Battilana, owns Amiga Corporation, and this holds the Amiga trademarks and copyrights. Hyperion Entertainment has an exclusive licence to develop and market AmigaOS 4.

> "There are two pillars I'm building Commodore on: retro and futurism. We can't just look back"

As Retro Games Ltd found in its bid to produce a replica of the Amiga 1200, legal disputes can get in the way of progress. Simpson is hopeful that, one day, the way forward will be simpler. "We're in very positive, respectful talks with Mike Battilana," he said. "Our dream is to reunite the Commodore and Amiga families, but only with care and cooperation, not the mistakes of the past. It won't happen overnight, but the desire is mutual. Watch this space."

In the meantime, Commodore is forging ahead. As well as the Commodore 64 Ultimate, it sells the Commodore 64X PC alongside joysticks and a range of merchandise from dog-tag necklaces and mouse pads to sweatshirts and cotton tees. The company is also looking to so some good in the wider world with a scheme called Commodore Care.

"It's about giving back," Simpson said. "Commodore Care intends to make life fairer for underprivileged kids, by giving them Commodore computers, so they may one day look back and feel that happiness we feel when we look back – but that they otherwise might not feel. Commodore did that for me, and so many others, and I want it to do the same for them."

The company is also setting up the Commodore 80s Dream Arcade at Caudwell Children's headquarters in Newcastle-under-Lyme in Staffordshire. "It will be a physical space for children with ADHD and autism to play, connect and explore retro tech. It simply reflects my belief that nostalgia can do good in the world," he added.

To that end, Simpson is clear that the Commodore 64 Ultimate is only the start, yet lays down a marker for what is yet to come. "Think of modern hardware wrapped in nostalgic charm," he said. "The Commodore 64 Ultimate is FPGA-powered, glows with game-reactive light, and runs real dusty 80s cartridges, or shiny new D64s on USB 'cassette'. But there are two pillars I'm building Commodore on: retro and futurism. We can't just look back.

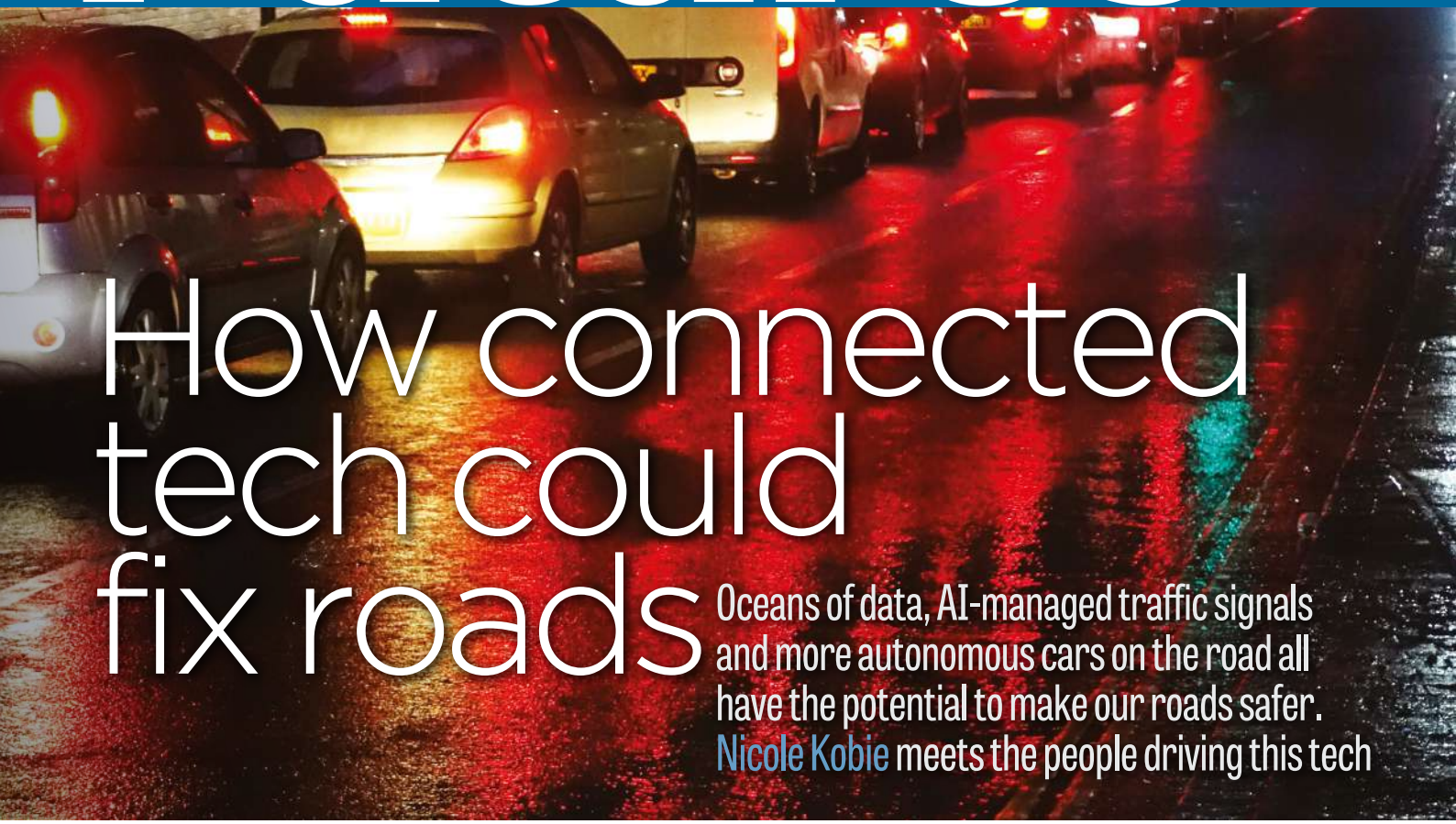
"We will have future products that will blend that retro soul with digital detox innovation – including transparent tech and distraction-free design. The goal will be to give people a way out from today's 'technology gone too far'. I can't say too much about our products already in development, but they are going to ride that wave as any good Commodore should."

TOP Commodore hopes that reviving the brand will strike gold for the firm

MIDDLE The back of the Commodore 64 Ultimate includes modern ports

BOTTOM The C64 Ultimate's menu allows you to set up various components

Futures



How connected tech could fix roads

Oceans of data, AI-managed traffic signals and more autonomous cars on the road all have the potential to make our roads safer. Nicole Kobie meets the people driving this tech

Cars are full of sensors and automation that allow vehicles to change lanes or brake without the driver doing much at all. Navigation systems reveal exactly what's on the road ahead, offering global wayfinding. And roads themselves are full of smart systems to manage junctions, change speeds on the fly and so much more.

So why are we stuck in traffic all the time? London drivers lost 101 hours trapped in congestion in 2024, while across the UK more widely, traffic cost an average 62 hours annually, according to data from the transport analytics company INRIX. Road safety continues to be a challenge, too, with 1,633 people killed in accidents last year. Another 27,904 suffered serious injuries.

"It really is a pivotal, critical issue for the UK," said Max Sugarman, CEO of ITS UK, at the MOVE 2025 conference in London in June. "In terms of how much progress we've been making, we've been plateauing – so we're not making huge strides or making great improvements"

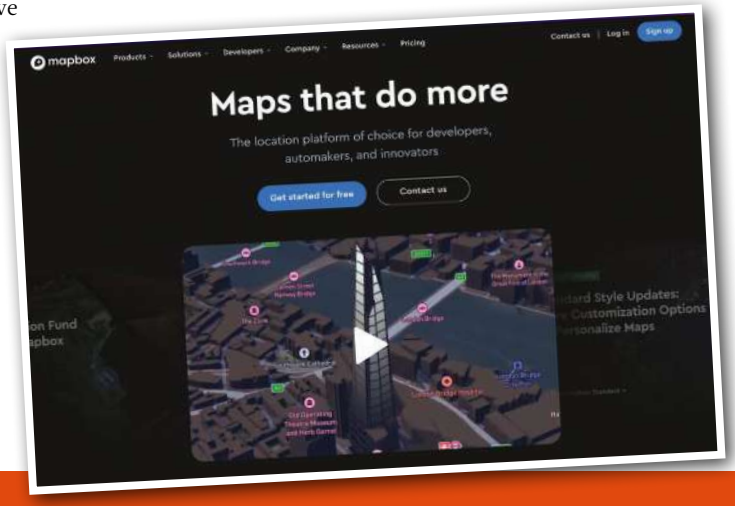
Some of this can't be solved with technology. No matter how many sensors you shove in an SUV, it's still going to hurt if the driver runs a red light and it T-bones your sedan. But there could be a critical role for technology. What if sensors, connectivity and AI could be cobbled together into a coherent system to manage roads to reduce traffic, improve safety and consider cyclists and pedestrians?

Better roads through data

The rise of sensors and ubiquitous connectivity means we have plenty of data available on how well the roads work now. "We have a machine driving around gathering massive amounts of data, but to increase road safety, something needs to be done with the data," said Gregor Schley, urban mobility and data expert, BMW Group.

Mapbox acts as the cloud storage provider for a wide range of mobility apps, including Strava and BMW's navigation tools, as well as delivery logistics systems for firms such as DPD – all in, it adds up to 85 billion GPS locations across 700 million devices. "They're generating telemetry data," said Geoff Clark, head of EMEA at Mapbox. "We use it to generate traffic data for navigation so we have the best route possible, the most efficient routes. "

That data can also be used to spot harsh braking zones – areas that could be more likely to see accidents. That aggregate data is shared with Michelin Mobility Intelligence, which works with local authorities and highway agencies to spot dangerous junctions or other points in the road. The hope is it can then improve those locations to avoid collisions.



BELOW Mapbox collects data from 85 billion locations around the world

Christopher Stokes, UK manager at Michelin Mobility Intelligence, says data can be applied across an entire road network to start predicting where serious accidents will happen by identifying risky locations.

Beyond fixing the problems in road networks, this data can also flag such spots to drivers. "You, as drivers in your local area, know exactly where the risky locations are in your town, and the people visiting have no idea," Stokes said, adding that the goal is to share such warnings with the public so they can avoid them if desired.

Smart traffic lights

Creating that green wave so cars never actually stop benefits drivers, but what about everyone else on the road, notably cyclists and pedestrians? Currently, most junctions treat cyclists like cars and wholly ignore pedestrians unless we push a "beg button" and wait our turn.

But what if cameras could see waiting pedestrians and prioritise them crossing? That's the idea behind AI-powered cameras being tested at Aston University in a project led by Dr Maria Chli.

The idea is simple: install a cheap, 360-degree camera at junctions and analyse data using deep reinforcement learning to manage the traffic lights. Chli told me at the Turing Institute's AI UK conference earlier this year about a trial at a junction near a major hospital in Coventry. This used the Aston system to prioritise emergency vehicles as well as staff on their way to work, as there are higher numbers of pedestrians than usual at the 8am and 8pm shift changes. "With this technique, we can tailor the priorities for each junction," she said.

The system reduces wait times for all travellers – on foot, on bikes or in cars – as it can actually see them all, unlike existing traffic management systems that rely on a cable embedded in roads that counts cars but not bikes or people. The system can also be told to give preferential treatment to pedestrians; perhaps at shift change or school start times, to give children more time to cross safely.

The system can be trained for a specific junction using simulations, and Chli said it takes about three days to start making good decisions. Setting aside the cost of the AI, the camera and controller itself only costs a few hundred pounds per junction – and no roads need to be torn up to install it.

In short, pairing this AI system with cheap cameras could lead to reduced traffic delays for everyone on the road and safer crossings that prioritise pedestrians, and all at a lower cost without major disruptions.

ABOVE Collected data can help to identify accident blackspots

Better drivers using driverless

You're cruising along the motorway when suddenly you see a sea of red tail lights ahead of you. There's no accident, no incident, but everybody has slowed down nevertheless, adding minutes to your journey.

This is known as a phantom traffic jam. In this example it's caused by people driving too closely to the car in front, or too quickly, meaning that when a car ahead taps their brakes, they need to slam on theirs, sparking a chain reaction that slows traffic and causes accidents.

Pairing this AI system with cheap cameras could lead to reduced traffic delays for everyone

Jonathan Sprinkle and Daniel Work, engineering professors at Vanderbilt University in Nashville, Tennessee, wondered if driverless cars and basic automated safety features could end this phenomenon. "In morning rush hour traffic, you see these patterns where these waves of tail lights form and those waves are known as phantom traffic jams," explained Work at the MOVE 2025 conference in London. "They are jams that are created based on the way that you and I drive. You tap on the brakes, the person behind you taps on the brakes more. It's a type of instability in the flow that creates these huge stop-and-go waves."

Work and Sprinkle argue that well-designed automated vehicles will end this frustrating feature of roadways because the car will keep a proper distance and maintain an ideal speed, and "know" it doesn't need to brake. It will also see such phantom traffic jams coming, slowing the speed to avoid them. All of this doesn't just benefit passengers in driverless cars; having enough automated or connected vehicles on the road could reduce or end phantom jams altogether.

The two researchers ran tests to prove this theory, first driving cars in a circle in a parking lot with a human driver in the lead pace car, before switching to a vehicle with adaptive cruise control. The difference was immediately clear. "Instead of racing into the back of the jam just to slow down and speed up again, it drives at a smooth and steady speed," said Work. "And that has a positive impact on the vehicles behind that also are forced to drive at a smooth and steady speed."

He notes that one car controlling another 20 is enough to reduce the fuel consumption of the other vehicles

Being smarter with speed management using real-time traffic data could help avoid phantom jams

LEFT Phantom jams caused by a driver touching the brakes are common on busy motorways

by 40%. "You can imagine that instead of letting traffic develop based on the way humans drive, if you let automated vehicles do it instead you could get rid of the traffic jams that human drivers create, and let automated vehicles, even when there are only a few of them out on the roadway, have a positive impact on everyone's commute," said Work.

But that theory didn't pan out when they sent a single car with automated cruise control out on an open roadway. Instead, the safety driver had to take the wheel because the braking of other cars was so extreme that the system disengaged. Clearly, one car alone isn't enough. But what if you had 100?

The two researchers paired up on a project to send 100 cars out on the same road, all driving differently, and see how it impacted traffic, with the goal of creating uniform flow for everyone to avoid phantom jams and use less fuel. "At the end of the day, the goal for this is to have the car streamline traffic and make it better for the people behind you as well," said Sprinkle.

They leased 100 cars, rounded up students to act as safety drivers and built a car automation system into Raspberry Pi computers that were plugged into the cigarette lighter for power. "Essentially these folks just drove around in a circle for a couple of hours until we were able to see what was happening," said Sprinkle.

Beyond that, Work's team built a network of 294 4K cameras to capture what other drivers were doing, analysing the data using a computer vision algorithm to track every car on the open road. They spotted a regular pattern to phantom jams. "Despite the fact that no-one tries to, they all create waves that travel backwards against the flow at 12 miles per hour," he said, adding that once you know that, you can build systems to avoid it.

Sprinkle noted that if you know a jam is coming up at your current speed, it makes sense to change your speed. "What you want to do is tell your future self you should slow down, congestion is coming," he said. "If I had just a little bit of information for what was happening a mile away, I could change what I do right now." But current mapping and satnav tools aren't real-time enough to enable this.

While the idea shows promise, they did note that other vehicles didn't necessarily want to slow down just because a smarter car ahead of them did – one lorry driver raised a finger at them while aggressively passing their slower moving car; it made the team feel like they should have been going faster. Shortly afterwards, they caught up with him, stopped in a phantom jam. "The algorithm was correct, but the implementation didn't help," said Sprinkle.

More work is needed, as ever, but the research suggests that being smarter with speed management using real-time traffic data could help avoid phantom jams – if we can get drivers to listen to each other, or the data, at least.

And if we can manage that, tech could help make our roads a bit safer.

Why tech breaks down and what we can do about it now

Nicole Kobie explains why we can't live in idealistic worlds when it comes to improving life on our roads

Tech often seems like a good idea in the lab and then struggles when it hits the real world – and there are few real-world environments more challenging than roads. The nation's motorways and streets may seem a good place to apply technology, as there's literally a rule book all users should follow. But we all know that when you put a person at the wheel, they very often go a bit bonkers – we've all experienced road rage and driven too fast, while hours of dash-cam footage on YouTube can attest to the extreme behaviours shown by some drivers.

Humans are the reasons that tech has often failed when it comes to improving roads. New smart motorways were scrapped in part due to a "lack of confidence" from drivers; no surprise when those already in place frequently suffered power outages. And research from Which? showed that more than half of drivers surveyed disabled one of the five main Advanced Driver Assistance Systems (ADAS) tools some of the time over concerns with safety and simply finding them irritating.

While we work to improve tech until it can become a useful solution for these very real problems – and admit that may never happen – what can we do to make roads safer?

There are plenty of simple answers, but they won't be popular to everyone. In terms of safety, discourage large cars, as the rise of SUVs has unquestionably come alongside a spike in pedestrian deaths. Drop all speed limits, rolling out a 20mph maximum in urban areas, a move that's reduced fatal or serious crashes by a third in London. Better road design, such as thinner roads with better crossings, can help. And rethink road safety from a cultural standpoint, making pedestrians the priority, followed by cyclists, an idea that's surfaced in so-called low-traffic networks (LTNs).

These policies may not sit well with everyone, but they're more popular than you may think: a leaked report ordered by then PM Rishi Sunak in 2024 showed that 45% of people living in a trial scheme supported LTNs, versus just 21% of people opposing them, while six in ten people weren't even aware they lived on a street with modal filtering.

That's safety. What of traffic? Investing in public transport is one solution, but it's a long-term one. Road pricing to discourage driving is another option, and while it has proven successful, must be backed by public transport alternatives. Both suggestions really come down to reducing the numbers of cars on the road, which is good news for the cars left on the road, of course.

So using technology to manage traffic could have real merit – if it can be made to work – but when it comes to safety we can act now without waiting on AI and the rest to mature as technologies.

PC PRO Next month

ON SALE
Thursday 2 October

Features

Wipe your devices

Whether you want to sell, recycle or gift your existing laptops, desktop PCs, tablets, phones or other gadgets, we explain how to make sure your data doesn't ship with it.

Features

Best of IFA 2025

Europe's biggest consumer tech show takes place in Berlin in early September, and both Tim Danton and Jon Honeyball will be there to pick out the hits from the misses.

Features

Build a home camera system for £30

Our in-house tinkerer Nik Rawlinson sets out to undercut systems costing hundreds with a £30 budget. Can he do it? Find out next month!

Labs

Mini PCs

There's a reason why mini PCs are growing in popularity even as they become more compact: they're a brilliant, efficient way to enjoy high performance for a low price. We put 11 contenders to the test.

Retro

Computers behind the iron curtain

Delve into the history of Vojislav Antonić, the Yugoslav engineer who, in 1983, devised a home-buildable computer called the Galaksija.

The Network

On-premises business backup

Put your data at risk and you're putting your business at risk. Dave Mitchell explains how to put safeguards in place and what backup products can help.

Futures

Glossary of the future

Clankers? Glazing? Vibe coding? Wondering what everyone's on about? Nicole has the tech slang you need in your vocabulary.

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The AI bubble is expanding so fast it must surely burst, argues Jon Honeyball

Everyone on the internet appears to be outraged about something. You can't move for social media postings lambasting some new cause or public issue. And yet many of these postings have little or no reference sources, and if they do, it's to a site whose information integrity is often, shall we say, somewhat lacking.

So I was intrigued by a particular thread on the hellscape that is X showing a photo of a poster from the University of East London (**tinyurl.com/373wifitrees**). It said: "Wi-Fi doesn't grow on trees. Your screen time is damaging the climate." Duly outraged, I went to read more at the University of East London's website (**tinyurl.com/373eastlondon**).

This makes the claim that the "growing demand for digital services has created a new challenge for the environment. Sending emails, texts, browsing the internet, uploading videos and more all come with a cost – a few grams of carbon dioxide are emitted due to the energy needed to run your devices and power the wireless networks you access.

"With over four billion people across the world using the internet, it is estimated that three per cent of world electricity is consumed by data centres – accounting for more greenhouse gas emissions than the entire aviation industry."

All of these are reasonable statements. However, a typical Wi-Fi access point is running at around 5W, and that is a really quite insignificant amount of power consumption in the broader context of a house's electrical requirements.

Another claim I have read is that you should delete unnecessary photos on your mobile device, because these are being backed up to one of many cloud storage facilities. And all of those pictures require storage, and that consumes power. Again, this is entirely true, but it must be put into context. Just what proportion of the energy consumption is related to those baby photos you took when your offspring first started to walk?

A bigger question arises about how much processing power is required to support the huge data centres that are being built by the big AI players. Some are claiming that all sorts of exotic power generating systems can be used, from vast solar panel arrays to small-scale nuclear reactors.

It's far from clear that this enormous rush to build ever-larger AI farms will be met with the appropriate power facilities to feed them, or whether the local networks will be brought down. Or whether the prices of wholesale electricity will go up to match the demand. It could be a requirement that such facilities should be entirely self-powered, but only a naive fool would assume that such an outcome is likely.

But will it all be necessary anyway? Is this a vast bubble that is about to burst? I read this post on X last week (**tinyurl.com/373cursor**): "Why AI is a house of cards: You pay $200 a year for an AI app (like Cursor). Cursor pays OpenAI $500 for API tokens ($300 of which is VC funding). OpenAI pays AWS $1,000 for compute ($500 of which is VC funding). $AWS pays $10k for $nvda GPUs. See the problem?"

Now I am not claiming that the figures are accurate, but there is an underlying truth here. None of this infrastructure can make money at the moment. It isn't an issue of "we will break even when we can scale out enough". The costs just continue to go through the roof. And adding in newer and faster generations of technology from Nvidia might seem like a good solution, but not if the workload is increasing at a rate that can consume every clock cycle that you throw at it.

Is this a race to the bottom, where only the companies backed by the deepest pockets can hang on long enough to pay the power bills, build the data centres and fill them with extraordinarily expensive hardware?

It feels like a game of Russian roulette played out by the biggest companies on the planet. When the music stops and the money runs out, the fall-out will be quite devastating. Or have we got to a point where these companies are simply too big to fail?

> "It feels like a game of Russian roulette played out by the biggest companies on the planet. When the money runs out, the fall-out will be quite devastating"

At some point, these enormous AI factories have to come up with a business model that actually works. In 2024, OpenAI lost $5 billion on revenue of just under $4 billion. But this is small fry: Google, as Alphabet, is spending $85 billion in 2025, up from initial estimate of $75 billion, on AI and other related technical infrastructure work. I have read that Microsoft is spending $80 billion in 2025, too.

At some point, this all adds up to an awful lot of money. Will the music stop soon?

Jon Honeyball is a founding editor of *PC Pro* and throughout its 31 years has been neither artificial nor intelligent. Email jon@jonhoneyball.com

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